Energy and Rural Land Use Planning in Ontario

Ontario

Ministry of Energy

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ENERGY

AND

RURAL LAND USE PLANNING

IN

ONTARIO

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EXECUTIVE SUMMARY - ENERGY AND RURAL LAND USE PLANNING IN ONTARIO

The purpose of this study is to present a discussion of opportunities for the conservation of energy in rural Ontario through the land use planning framework.

The study was conducted on behalf of the Ontario Ministry of Energy by MacLaren Plansearch Inc. Study management and supervision was undertaken on behalf of the Ministry by Mr. John E. L. Farrow of Currie, Coopers and Lybrand.

The consideration of planning-oriented energy conservation opportunities for rural Ontario may be seen as being important for several reasons. First, the body of knowledge which exists with respect to energy conservation and land use planning is generally urban-oriented and usually not transferable to the rural situation. Second, development patterns in rural Ontario are generally more heavily dependent, on a relative basis, on transportation than are urban patterns, largely as a result of the low density nature of rural development. Also, land use patterns in rural areas are more strongly oriented to primary economic activities than are urban patterns. Accordingly, rural land use patterns are amenable to change in very different and distinctive ways. The nature and characteristics of cash crop farming, for example, play an extremely important role with respect to the determination of the spatial distribution of land use within an agriculturally-oriented, rural municipality. As a result of these various factors, it is felt that an assessment of planning-related opportunities available in rural areas can lead to a more complete strategy for the conservation of energy in Ontario.

This study deals with regional as well as site-specific matters. The primary component of the study consists of an analysis of rural energy consumption patterns at the municipal level. Due to the amount of diversity which exists in terms of physiography, economic activity and land use patterns, three distinct baseline models have been formulated for the purposes of analyzing energy consumption patterns in rural Ontario. These three models are intended to be representative of township units located in southern, central and northern Ontario with economic and land use orientations to agriculture, recreation (waterfront cottages), and renewable resources (forest harvesting) respectively.

For each base model examined in the study, several alternative land use arrangements, which reflect variations in existing patterns, were formulated and their effects upon base levels of energy consumption analyzed. Planning policy considerations which may contribute to the conservation of energy through the modification of baseline land use arrangements are also identified.

This study also contains analyses of on-site, energy-related planning considerations. Particular reference is made to energy-conserving opportunites available through alternative site planning practices, taking into account the unique climatic characteristics of rural areas. The appropriateness of using site plan control powers in rural municipalities to achieve more efficient use of energy is also assessed.

The analyses of the baseline models and the subsequent application of land use variations, or tests, have revealed interesting and important land use planning considerations.

For the southern, agriculturally-oriented model, it was found that by substantially increasing the incidence of scattered, non-farm residential development, total energy consumption increased by 35 percent while per capita energy consumption increased by only about 1 percent. The addition, or revitalization, of a centrally-located hamlet was found to contribute to a decline in transportation-related energy consumption over the baseline situation, as a result of a reduction in total travel distances. Per capita energy consumption associated with this alternative was determined to be approximately 10 percent less than the baseline model. A third test, involving the clustering of non-farm residential development as well as the previously introduced hamlet function was also found to contribute to a significant decrease in per capita energy consumption. The clustering aspect, however, was found to be only minimally responsible for this decline, thereby reinforcing the importance of the hamlet function.

For the central Ontario, recreation (waterfront cottage) - oriented township, the addition of two strategically located hamlets, to serve the needs of seasonal residents, was found to have a significant effect on base levels of energy consumption; reductions in total and per capita energy consumption of approximately 10 and 25 percent respectively were experienced. The addition of clustered cottage development, as opposed to strip-type development, when combined within the two aforementioned hamlets, was found to reduce total energy consumption by 7 percent and per capita energy consumption by approximately 40 percent, over the base situation. The third test, considers the effects on energy consumption of the conversion of seasonal residences to permanent dwellings, as well as the previously introduced strategic hamlet and clustered cottage development variations

It was found that the random conversion of seasonal residences served to negate all per capita energy savings accrued in the previous two tests. Total energy consumption related to this model represented an increase of approximately 40 percent when compared to the base situation.

The two main variations applied to the northern, renewable resource (forestry) based township unit, dealt with the addition of a hamlet, and improved linkages in the township's road network. The tests applied to the base situation were found to have only a minor effect on total and per capita levels of energy consumption. The first test involving the addition of a hamlet was found to lead to the consumption of 3.4 percent more total energy than the baseline model, while in per capita terms an energy saving of 3.0 percent over the base situation was experienced. Improvements to the road network of the model township resulted in only minor total and per capita savings. The third test, which combined the previous two tests, was found to consume 2.2 percent more total energy than the base situation while a 4 percent decrease in per capita consumption was determined.

The section of the study pertaining to on-site energy consumption is not test or evaluation-oriented but rather serves to convey information and concepts. A specific section concerned with site planning notes the major climatic variables which affect energy consumption in rural areas. The major climatic variables discussed are the same as those which affect space heating requirements in urban areas. Their magnitude and importance, however, differ greatly. Observations and conclusions made concerning the varying importance of such variables from urban to rural situations, point to the need for the development of "rural-specific" site planning practices; the transfer of urban-oriented site

planning practices may not be sufficient to mitigate the effects on space heating requirements imposed by rural climatic conditions.

The final section of the study serves to summarize the various observations and conclusions arising from the previous sections. On the basis of such observations and conclusions, this section also suggests alternative planning policy and regulation considerations which, if implemented, will lead to the more efficient use of energy in each of the three model situations. Recommendations pertain, in particular, to a municipality's two main planning documents, the Official Plan and Zoning By-law.

ENERGY AND RURAL LAND USE PLANNING IN ONTARIO

Executive Summary *(i)*
Table of Contents *(vi)*
List of Appendices *(vii)*
List of Tables & Figures *(viii)*

TABLE OF CONTENTS

SECTION	TITLE	PAGE NO.
1.0	*INTRODUCTION*	*1*
2.0	*DESCRIPTION OF MODELS*	*5*
	2.1 Agricultural Baseline Model and Associated Tests	5
	2.2 Recreation Baseline Model and Associated Tests	7
	2.3 Renewable Resource Baseline Model and Associated Tests	8
3.0	*SUMMARY OF TEST APPLICATIONS – OBSERVATIONS AND CONCLUSIONS*	*10*
	3.1 Agricultural Baseline Model and Tests	11
	3.1.1 Observations	11
	3.1.2 Conclusions	14
	3.2 Recreation Baseline Model and Tests	15
	3.2.1 Observations	15
	3.2.2 Conclusions	19
	3.3 Renewable Resource Baseline Model and Tests	20
	3.3.1 Observations	20
	3.3.2 Conclusions	23
4.0	*RURAL SITE DESIGN OPPORTUNITIES*	*25*
	4.1 Site Planning and Energy Conservation	25
	4.2 Climatic Factors	28
	4.3 Institutional Arrangements	32
	4.4 Official Plan Policies	33
	4.4.1 Site Plan Control	33
	4.5 Zoning By-laws	35
5.0	*LAND USE PLANNING CONSIDERATIONS*	*37*
	5.1 Considerations for Agriculturally - Based Townships in Southern Ontario	37
	5.2 Considerations for Recreation - Based Townships in Central Ontario	39
	5.3 Considerations for Renewable Resource - Based Townships in Northern Ontario	42

APPENDICES

APPENDIX I - *GRAPHIC PORTRAYAL OF BASELINE MODELS AND TESTS*

APPENDIX II - *BASELINE MODEL AND TEST ASSUMPTIONS*

APPENDIX III - *ENERGY CONSUMPTION – BASELINE MODELS AND TESTS*

LIST OF TABLES AND FIGURES

TABLES

TABLE NO.	TITLE	PAGE
3.1	Summary of Energy Consumption - Agricultural Baseline Model and Tests	12
3.2	Summary of Energy Consumption - Recreation Baseline Model and Tests	16
3.3	Summary of Energy Consumption - Renewable Resource Baseline Model and Tests	21
4.1	Rural Climatic Conditions Expressed as a Percentage Magnitude of Base Urban Conditions	30

FIGURES

FIGURE NO.	TITLE	PAGE
4.1	Site Design Concept	26
4.2	Site Design Concept	27

1.0 INTRODUCTION

The evolving understanding of the relationship between land use planning and energy conservation is characterized by an increased emphasis on land use efficiency. An efficient use of land is thought to minimize energy consumption by maximizing transport network efficiencies and minimizing on-site energy requirements, including energy associated with space heating. Consideration of such factors within the perspective of land use planning must, therefore, follow a broad research spectrum ranging from the regional level to that of the individual site.

The purpose of this study is to develop and analyze various alternative rural land use planning practices in order to assess their implications on current levels of energy consumption in rural Ontario.

In considering energy consumption within the rural perspective, recognition must be paid to the general low density of rural land use in Ontario. This factor has important ramifications upon energy consumption, particularly as it relates to transportation. Within the urban perspective, it has been suggested that transportation accounts for approximately 55 percent of a household's energy consumption.[1] As a result of the low density nature of development in rural areas, it is suspected that transportation-related activities probably account for *greater than* 55 percent of a rural household's total energy consumption as in the urban situation.

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1 Clark S.J., "Residential Site Design and Energy Conservation" in Energy-Efficient Community Planning - Proceedings of Seminars held by the Ontario Ministry of Energy, January, 1980. - Province of Ontario, Ministry of Energy, October, 1980.

The second major component of a household's energy consumption is space heating. Within the urban perspective it is apparent that there are large amounts of flexibility and opportunity for reducing space heating demands, primarily through increased residential densities. The same degrees of flexibility and opportunity do not, however, exist within the rural situation as a result of lower rates of growth and the inherently lower development densities associated with rural land use systems. The only apparent means to effectively reduce space heating requirements in rural areas appear to be through careful and innovative site planning and, wherever possible, through the clustering of development. This study, therefore, focuses upon an analysis of the spatial distribution of rural land uses, the transportation networks which tie such uses together and also upon effective site planning practices.

To assess the effectiveness of alternative land use planning approaches aimed at achieving more efficient use of energy in rural areas, knowledge of existing levels of energy consumption is required. A method is outlined herein which analyzes existing land use arrangements within typical rural townships to facilitate the formulation of a "base knowledge" of current levels of *energy consumption*. By applying assumptions regarding such matters as travel patterns, trip destinations and space heating needs, a detailed account of existing or base levels of energy consumption is achieved.

Once a base knowledge is established, assumptions associated with alternative rural land use interrelationships may then be introduced. The application of alternative approaches serves within this study to test various hypotheses regarding energy consumption. These alternatives are referred to herein as *"tests"*. By determining levels of energy consumption

associated with the existing or base situation as well as with alternative approaches, or tests, it is possible to quantitatively evaluate and compare the energy conserving qualities of each particular planning approach. After a comparison of the quantitative variables of each test has been made, an assessment of the various planning policies and associated regulations required to identify the most effective approach can be made.

In analysing levels of energy consumption in rural Ontario, an appreciation of the diversity of the Province's geography, including primary resource activities and corresponding land use arrangements and patterns is required. Three typical or *model* rural townships with varying economic bases have been selected for analysis in the study in order to reflect this diversity. More specifically, the townships have been selected from southern, central and northern regions of the Province in an attempt to represent agricultural, recreational and renewable-resource based economies and their associated characteristic land use patterns.

The analysis of the southern Ontario situation uses an *agricultural baseline model* which grants specific recognition to the phenomenon of scattered non-farm residential development.

The rural recreation area of central Ontario is represented by a *recreation baseline model.* The seasonally utilized waterfront cottage is the predominant land use with recognition also given to a minimal number of permanent farm residences.

For the rural northern Ontario situation the study considers a township which is economically-oriented towards the forest industry. This *renewable resource baseline model* is predicated upon four main considerations: the location of primary resource extraction (forest harvesting), secondary resource processing (a pulp mill), an associated service townsite, and scattered rural residential development.

These three baseline models, and associated tests, provide sufficient flexibility and latitude to represent many of the diverse land use situations found in rural Ontario. Through manipulation, each model may be re-organized to reflect various alternative land use and network scenarios. For example, the agricultural baseline model, which depicts a strong agricultural orientation, was altered to represent a situation in which the role of agriculture has decreased and non-farm development has taken hold.

Each of the three baseline models, and corresponding tests and assumptions are outlined in greater detail in Section 2. An evaluation of each of the tests in terms of their effect on baseline levels of consumption, in both gross and per capita terms is contained in Section 3.

In addition to the consideration of regional or macro levels of investigation, the scope of this study also includes the evaluation of alternatives for on-site energy efficiency. Within this study the investigation of on-site energy efficiency focusses upon rural site planning alternatives for dwellings and other structures.

Site planning arrangements are discussed in Section 4.0. Included in this discussion is an analysis of climatic conditions in rural areas which warrant particular attention with respect to site design and the minimization of space heating demand. A discussion of considerations related to official plan policies, site plan control and zoning regulations is also presented in this section.

A fifth section presents various planning policy considerrations for each of the three model townships examined in this study. In addition to making observations regarding current trends and issues pertaining to each of the three economic land use systems, this section provides planning considerations and recommendations associated with various planning instruments, including Official Plans and Zoning By-laws.

2.0 *DESCRIPTION OF MODELS*

In order to effectively examine existing levels of energy consumption within the rural Ontario context, representative townships were selected as models. Each township or model is considered as isolated and independent of its surroundings. This approach facilitates an independent analysis of existing and hypothetical network characteristics and patterns of land use and development within the township unit.

The following sub-sections present each of the baseline models, as well as the various associated tests employed.

2.1 *Agricultural Baseline Model and Associated Tests*

The agricultural baseline model serves to represent the spatial distribution and interaction of land uses commonly found within an agriculturally-oriented township unit. The model township is presumed to be situated outside of the "development shadow" of a major urban centre, and within Southern Ontario.

The agricultural baseline model is predicated upon certain basic assumptions regarding the total area of the township unit, average farm size, number of farm and non-farm residences, demographic characteristics and travel patterns related to both farm and non-farm properties.

Three tests have been developed which represent changes to the base situation. These tests also represent a foundation for the formulation of alternative land use policies. More specifically, the objectives of the three tests are:

- *Test A1: Non-Farm Residential Growth*
  - *to explore changes in energy consumption in the baseline model as a result of a growth in the amount of scattered non-farm residential development.*

- *Test A2: Addition of Hamlet*
  - *to examine the effect on energy consumption of a centrally-located hamlet offering basic urban services (farm and family service shopping, education and formal recreation).*

- *Test A3: Hamlet and Clustered Non-Farm Development*
  - *to evaluate the effect on energy consumption of clustered non-farm residential development in addition to a centrally-located hamlet.*

In presenting the agricultural model and associated tests, an attempt has been made to portray the recent evolution of a southern Ontario township. The baseline model reflects the rural depopulation experienced during the 1950 - 1970 period which resulted in generally low rural population and development densities. From this hypothetical baseline, three tests involving non-farm residential growth; a central hamlet and clustered non-farm residential development were applied. The application of the tests, which are intended to more accurately reflect the present day situation in many agricultural townships, allows for an appreciation of the energy implications of many features of the current rural land use system of southern Ontario. In this manner, the model approximates present day situations found in the Townships of West Williams and Adelaide (Middlesex), Romney (Kent), and Malahide (Elgin).

A description and listing of the basic assumptions employed in the baseline model and the corresponding tests is provided in Appendix II.

2.2 *Recreation Baseline Model and Associated Tests*

The recreation baseline model is intended as an examination of the typical recreation-oriented land use pattern commonly found in those central Ontario townships which contain significant waterfront resources. The baseline model assumes recreation, primarily in the form of seasonally-occupied cottages, located in a "strip development" pattern along lakeshores and waterfronts, as the dominant economic and land use activity. Farming is considered as a secondary use of land, occurring in a scattered manner reflecting the dispersed nature of available agricultural land and grazing areas. These farm uses are permanent in nature, and utilized on a year-round basis.

The recreation baseline model and associated tests are predicated on a number of assumptions, concerning permanent and seasonal populations alike, regarding such matters as township unit size, number of seasonal and permanent residences, development and demographic characteristics and travel patterns. The model has been formulated on the basis of observations of component land use patterns of various townships located in the Muskoka and Haliburton regions of central Ontario. It should be noted that the baseline model does not purport to represent the present day "Muskoka" situation, but rather the addition of each test is intended to develop the model toward the present day situation. The intent of this evolutionary method of modelling is to permit an analysis of the effect on energy consumption of common, existing features of a typical recreation-oriented land use system.

The objectives of the three tests applied are:

- *Test R1: Introduction of Hamlets*
  - *to examine the effect on baseline energy consumption of the introduction of two strategically located hamlets which provide basic services for seasonal residents.*

- *Test R2: Hamlets and Clustered Development*
  - *to examine the effects on energy consumption of the incorporation of clustered forms of cottage development into appropriate areas of the Township in addition to aforementioned hamlets.*

- *Test R3: Conversion to Permanent Residences*
  - *to consider the effect on energy consumption of the random conversion of approximately 25 percent of the seasonal residences to permanent dwellings while also considering the aforementioned hamlets and clustered forms of cottage development.*

A description and listing of the basic assumptions employed in formulating the baseline model and amended assumptions utilized in the three tests are contained in Appendix II.

2.3 *Renewable Resource Baseline Model and Associated Tests*

The renewable resource baseline model represents a township unit located in Northern Ontario. The model is intended to characterize northern municipalities with limited infrastructure and development patterns which are historically linked to the harvesting of primary resources (i.e., timber). The model reflects the isolated nature of such municipalities with the only major connections to other municipalities consisting of a single major highway (Trans-Canada), industrial rail service and telecommunication linkages.

The renewable resource baseline model consists of four main components:

- primary resource extraction (logging activity);
- secondary resource processing (pulp mill);
- an associated town-service area;
- scattered rural residential activity.

The primary energy variables considered within the context of this model include: the random pattern of settlement found within the rural portion of the township, resulting from various constraints on development (rock outcrops, muskeg) and a historical lack of planning controls, as well as the variable location of forest harvesting activity throughout the resource area according to forest management practices and master plans adopted by various enterprises and approved by the Ministry of Natural Resources.

The baseline model is intended to be representative of such municipalities as Marathon, Longlac and Dorion Townships (Thunder Bay District) and Field Township (Nipissing District).

The objectives of the three tests applied in this case are:

- *Test F1: Addition of Hamlet*
  - *to analyze the effects on energy consumption of the introduction of a strategically located hamlet which provides basic services (grocery and sundry shopping, education and formal recreation) for rural residents, thereby reducing trips to the townsite.*

- *Test F2: Improved Road Network*
  - *to consider the effects on energy consumption of functional modifications to the road network pattern in order to improve access to the townsite primarily from rural areas.*

- *Test F3: Hamlet and Improved Road Network*
  - *to consider the combined energy implications of both the hamlet and the improved road network.*

A brief description of the baseline model, including component assumptions, and associated tests is provided in Appendix II.

3.0 SUMMARY OF TEST APPLICATIONS – OBSERVATIONS AND CONCLUSIONS

The previous section of this study has outlined the basic considerations associated with the calculation of energy consumption in the three baseline model rural Ontario townships and associated test alternatives.

The purpose of this section is to convey the results of various tests in terms of their effect upon baseline levels of energy consumption. Baseline model and test results have been summarized on Tables 3.1-3.3 in terms of total as well as per capita energy consumption. Energy consumption is expressed as the total amount of energy, in gigajoules (GJ), consumed in each case. Consideration has been given to the different fuel efficiencies and types of fuel used in transportation and space heating, as well as the respective caloritic conversion factors used to translate litres of each fuel type into a single, common denominator: total joules.

In computing the total energy requirements, the following sources of energy consumption have been considered.

a) *Transportation*

i) Automobile

- gross and per capita fuel consumption associated with travel to:
  - commercial centres;
  - service shopping;
  - recreation centres and specialty activities (specialty shopping, doctor, entertainment);
  - employment.

ii) School Bus and Road Maintenance Vehicles

- gross and per capita fuel consumption associated with the operation of school buses and road maintenance vehicles.

iii) Total Transportation Energy Consumption

- total gross and per capita transportation fuel consumption (i & ii).

b) *Space Heating*

i) Residential Space Heating Requirements

- gross and per capita fuel consumption associated with space heating for the various types of residential development identified.

A summary and analysis of energy consumption related to each of the twelve scenarios examined is presented in the following subsections. Reference should also be made to Tables 3.1, 3.2 and 3.3 as well as Appendix III.

3.1 AGRICULTURAL BASELINE MODEL AND TESTS

3.1.1 Observations

Agricultural Baseline Model

The Agricultural Baseline Model reflects conditions in a township where the principal land use activity is farming. There are no hamlets, commercial service centres or other areas of concentrated urban development in the Agricultural Baseline Model. The total amount of energy consumed in this model has been determined to be 180,900 GJ per annum, with a per capita consumption of 84.1 GJ per annum.

TABLE 3.1

SUMMARY OF ENERGY CONSUMPTION
AGRICULTURAL BASELINE MODEL AND TESTS

	Baseline Model	TEST A1 Non-Farm Residential Growth	TEST A2 Addition of Hamlet	TEST A3 Hamlet and Clustered Non-Farm Development
Total Transportation Energy Consumption ($GJ \times 10^3$)	63.3	82.8	61.0	61.0
Total Residential Space Heating Energy Consumption ($GJ \times 10^3$)	117.6	161.6	166.0	170.4
Total Energy Consumption ($GJ \times 10^3$)	180.9	244.4	227.0	231.4
Per Capita Energy Consumption (GJ)	84.1	84.3	76.3	75.9

Non-Farm Residential Growth: (Test A1)

By increasing the amount of non-farm residential development from 50 residences, as in the baseline model, to 300 residences, no appreciable change in annual per capita energy consumption was observed. The principal reason for this stable energy position is due to the fact that increased consumption associated with a greater total travel distance related to non-farm employment commuting is offset by proportionately lower space heating energy requirements. Also the increase in the number of non-farm residents has not required a substantial increase in municipal services. A greater increase in the amount of non-farm development may, however, have had a pronounced effect on energy required for such service, due to the fact that changes of a basic level or threshold size are required before significant increases in services are required. Accordingly, it is suggested that the relationship between level of service required and change in population is not linear, but rather step or threshold progressive.

With respect to total energy consumption, the Test A1 scenario required approximately 244,000 GJ, or 37.4 percent more energy than the baseline model. In summary then, while per capita consumption increased only minimally as a result of Test A1, a large increase in total energy consumption occurred.

Addition of Hamlet: (Test A2)

The introduction of a centrally-located hamlet has served to significantly reduce per capita energy consumption. Per capita energy consumption associated with Test A2 is approximately 76.3 GJ, or 9.3 percent less than required in the baseline model. The reason for this significant reduction is due to a lesser amount of travel required to a central hamlet than to an outside urban centre.

Total energy consumption associated with Test A2 is 227,000 GJ, representing a 25 percent increase in total consumption over the baseline model. This increase is due to greater amounts of development over and above the base case. As is borne out by the per capita figures, however, the rates of consumption associated with greater amounts of development are not, on a proportional basis, as large as those associated with the baseline model, primarily due to changes in travel behaviour. Accordingly, although any growth will cause increases in total energy consumption, proportional levels of consumption may be reduced through alternative planning considerations, thereby reducing per capita consumptions.

Hamlet and Clustered Non-Farm Development: (Test A3)

The clustering of non-farm development, beyond the addition of a central hamlet as in Test A2, appears to have had a marginal effect on per capita energy consumption. Rates of per capita consumption have declined from 76.3 GJ, in Test A2, to 75.9 GJ in Test A3, or approximately 0.5 percent, when compared to the baseline model. Per capita space heating requirements have increased marginally over test A2. Per capita travel consumption requirements however have decreased slightly over test A2. The overall number of gigajoules required per capita per annum is approximately the same as in test A2.

3.1.2 *Conclusion*

i) Total per capita consumption of energy does not appear to increase dramatically by the addition of random, non-farm residential development because of the similarity in the average levels of per capita energy consumption for farm and non-farm families.

ii) The introduction of a basic commercial centre to supply daily shopping and personal service needs to township

residents will significantly reduce annual per capita energy consumption by minimizing travel out of the township. This effect has been observed in the test models even when associated levels of non-farm residential development are increased.

iii) Clustering of new non-farm residential development reduces consumption related to transportation so as to ameliorate increases in total per capita consumption as a result of the additional space heating requirements. The effective clustering of non-farm residential development into hamlets which can support local service and shopping opportunities has the potential to decrease total per capita energy consumption beyond the levels experienced in the township before the introduction of significant non-farm residential development.

Reference is made in Section 5.0 regarding the application of the above-noted conclusions to the formulation of energy-sensitive planning policies and regulations.

3.2 RECREATION BASELINE MODEL AND TEST

3.2.1 Observations

Recreation Baseline Model

The recreation Baseline Model simulates an actual geographic township where waterfront development in the form of seasonal residences is the predominant land use. A minimal number of permanent residences are also incorporated in the model. However, most of the employment, shopping and personal service opportunities are assumed to be available only outside of the township. The per capita energy requirements in this model have been determined to be 29.6 GJ (gigajoules) per annum (Table 3.1). Consumption related to transportation amounts to 99% of all energy requirements in the recreation baseline model.

TABLE 3.2

SUMMARY OF ENERGY CONSUMPTION
RECREATION BASELINE MODEL AND TESTS

	Baseline Model	TEST R1 Introduction of Hamlets	TEST R2 Hamlets and Clustered Development	TEST R3 Conversion to Permanent Residences
Total Transportation Energy Consumption ($GJ \times 10^3$)	32.1	14.5	15.3	16.6
Total Residential Space Heating Energy Consumption ($GJ \times 10^3$)	3.5	17.8	17.8	33.0
Total Energy Consumption ($GJ \times 10^3$)	35.6	32.3	33.1	49.6
Per Capita Energy Consumption (GJ)	21.6	16.6	13.2	21.2

Introduction of Hamlets: (Test R1)

The addition of two strategically located hamlets with 50 new permanent residences in each had the effect of reducing total per capita energy consumption per annum by 3.0 gigajoules or approximately 15 percent. Although space heating requirements have increased almost five-fold, the dominant source of energy consumption, transportation, has been decreased dramatically as a result of the introduction of local shopping and personal service outlets in the hamlets. Consumption related to transportation now amounts to 45% of all energy requirements. The actual reduction in energy consumption related to transportation is 61%.

Hamlets and Clustered Development: (Test R2)

Two identical clusters of 65 cottages have been added to the test R1 model. This development comprises a total of 130 new seasonal residences in two "subdivisions" which have access to undeveloped waterfronts and which are in proximity to the major transportation artery in the township. The effect of this test is to reduce per capita energy consumption per annum for both travel and space heating requirements. As a result, total per capita energy consumption has been reduced by 3.3 gigajoules per annum over the test R1 model, and this reduction amounts to savings in total energy consumption of over 32% of the baseline totals per annum. Consumption related to transportation in this alternative amounts to 47% of all energy consumption in the township.

Conversion to Permanent Residences: (Test R3)

In the test R2 model, approximately 20% of all households in the township were considered permanent residences. Test R3 involves the conversion of 130 seasonal dwellings to permanent dwellings so that 40 percent of all households in the township are now considered permanent residences. No new dwellings have been added in this test. However, all shopping and personal service opportunities which were added to the township in previous tests have been preserved. The effect of this test is to increase the total per capita energy consumption per annum to over 1.6 gigajoules above the baseline model total. As would be expected, the doubling of the number of permanent dwellings in the model has had the effect of doubling the space heating requirements in the township. The increase in number of permanent residences has also increased the total travel consumption in the township because more of the local population will be making trips for shopping and personal services within the township on a year round rather than on a seasonal basis. Consumption related to transportation in this alternative amounts to 33% of all energy consumption in the township. This comparatively low percentage of consumption related to travel is a result of two factors:

i) 60% of all residents still only travel within the township on a seasonal basis;

ii) compared to the previous models, test 3 includes a disproportionate share of energy consumption related to space heating.

Although the percentage of consumption related to travel is comparatively low in this model, the total consumption of 206 litres per capita per annum is similar to the corresponding travel consumption total in the test R1 model (Table 3.1).

3.2.2 *Conclusions*

i) Per capita consumption of energy in a typical Ontario township which is dominated by seasonal land use (i.e. summer cottages), is almost totally attributed to travel-related consumption.

ii) The introduction of shopping and personal service opportunities in the township can result in total per capita energy savings of up to 15 percent per annum by minimizing travel outside of the township for necessities such as groceries, and for other services (i.e. laundry, alcoholic beverages, entertainment, etc.) desired by seasonal residents.

iii) The development of clustered seasonal dwellings in strategic locations in the township, in addition to the introduction of local shopping and service functions, can further reduce per capita energy consumption by a substantial amount per annum.

iv) The conversion of a significant number of seasonal dwellings (up to 40 percent) to permanent residences negates the efficiencies gained in the implement- ation of other energy conserving land use alternatives such as the development of local shopping opportunities or clusters of seasonal residences.

Reference is made in Section 5.0 regarding the application of the above noted conclusions to the formulation of energy-sensitive planning policies and regulations.

3.3 RENEWABLE RESOURCE MODEL

3.3.1 Observations

Renewable Resource Baseline Model

The renewable resource baseline model incorporates elements of real municipalities with economies based on renewable resources such as forestry. The calculation of per capita energy consumption related to space heating in the resource baseline model and its associated alternatives considers the climatic attributes of northern locations associated with non-renewable resource-based municipalities depicted by this model. The per capita energy requirements in the renewable resource baseline model have been determined to be 63.2 GJ (gigajoules) per annum (Table 3.1). Consumption related to transportation amounts to 18% of all per capita energy requirements per annum in the renewable resource baseline model.

Addition of Hamlet: (Test F1)

The introduction of a hamlet in the rural area to provide more shopping and services within the township resulted in a per capita reduction of energy consumption related to travel of 1.9 gigajoules per annum. Per capita space heating requirements did not change as a result of the addition of 50 new dwellings with the establishment of the hamlet. Consumption related to travel has been minimally reduced to 15% of all per capita energy requirements per annum.

TABLE 3.3

SUMMARY OF ENERGY CONSUMPTION
RENEWABLE RESOURCE BASELINE MODEL AND TESTS

	Baseline Model	TEST F1 Addition of Hamlet	TEST F2 Improved Road Network	TEST F3 Hamlet and Improved Road Network
Total Transportation Energy Consumption ($GJ \times 10^3$)	28.5	25.1	26.4	23.3
Total Residential Space Heating Energy Consumption ($GJ \times 10^3$)	131.9	140.7	131.9	140.7
Total Energy Consumption ($GJ \times 10^3$)	160.4	165.8	158.3	164.0
Per Capita Energy Consumption (GJ)	63.2	61.3	62.4	60.7

Improved Road Network:(Test F2)

Improved linkages in the internal transportation network of the resource-based township resulted in a per capita reduction from the baseline case for travel-related energy consumption of 0.8 gigajoules per annum. This reduction amounts to a fuel saving of 24 litres per capita per annum (Table 3.1). There is no change in space heating requirements in this alternative so travel consumption savings comprise the entire amount of energy conservation associated with this test. Consumption related to travel in this model amounts to 17 percent of all per capita energy requirements per annum which represents a reduction of only one percent from the baseline model.

Hamlet and Improved Road Network: (Test F3)

Test F3 combines the attributes of both tests F1 and F2 to the resource model so that a hamlet, with 50 new residences and limited shopping and services, is introduced in addition to improved linkages to the internal transportation network of the township. As in both previous tests, the total per capita reduction in energy consumption per annum is entirely attributable to savings in the transportation component. These savings amount to 2.5 gigajoules per capita per annum which is approximately equal to the combined savings in travel-related fuel consumption in tests F1 and F2. Consumption related to travel in the test F3 model comprises approximately 14.3 percent of all per capita energy requirements per annum.

The 2.5 gigajoule reduction in travel-related energy consumption in the test F3 model amounts to the conservation of 74 litres of fuel per capita per annum. The magnitude of these savings may be established by multiplying the per capita fuel savings by the total population in the test F3 model which results in an annual reduction in consumption of almost 200,000 litres in the township.

3.3.2 *Conclusions*

i) The application of various land use and transportation network alternatives to a typical renewable resource-based township results only in conservation of energy consumption related to transportation . The various alternatives have not effected changes in consumption of space heating energy requirements which comprise the majority (upwards of 80%) of all per capita energy requirements per annum in typical resource-based townships.

ii) The inability of alternative land use arrangements to influence space heating requirements in typical resource-based townships is a function of two factors:
   - latitude/climate
   - a low probability and magnitude of change in the number and type of housing units and family size in resource-based townships. Demographic changes are normally far less dramatic in resource-based townships than in agriculture or recreation-based townships which normally have considerably larger populations and which traditionally experience more pressure for residential expansion due to their proximity to major urban centres.

iii) Energy conservation by any means will be characteristically lower in resource-based townships than in other types of rural townships because of their smaller populations; their predominant location in northern areas where more per capita energy is required; and their normally substantial distances to larger urban centres for the provision of shopping and other services.

Reference is made in Section 5.0 regarding the application of the above-noted conclusions to the formulation of energy-sensitive planning policies and regulations.

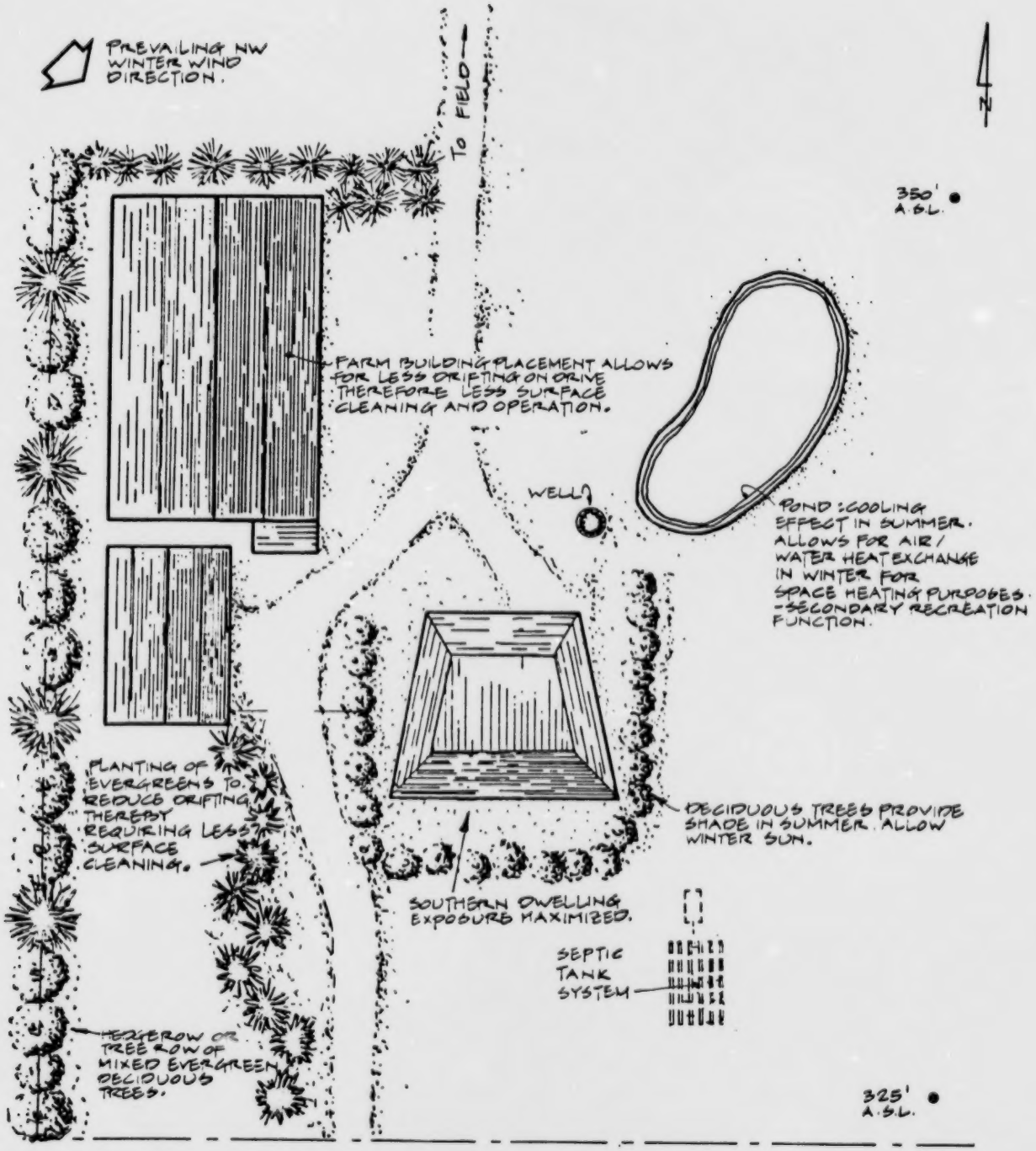
4.0 RURAL SITE DESIGN OPPORTUNITIES

The purpose of the following two sections is to identify and discuss site-oriented energy conserving measures which are applicable in rural Ontario. The fact that site planning and design can serve a role in the conservation of energy is well established. The majority of previous research work in this area, however, has a distinctive orientation to the urban setting. While many urban-oriented concepts and considerations are applicable in the rural setting, there are several unique factors which provide opportunities for energy conservation in rural areas.

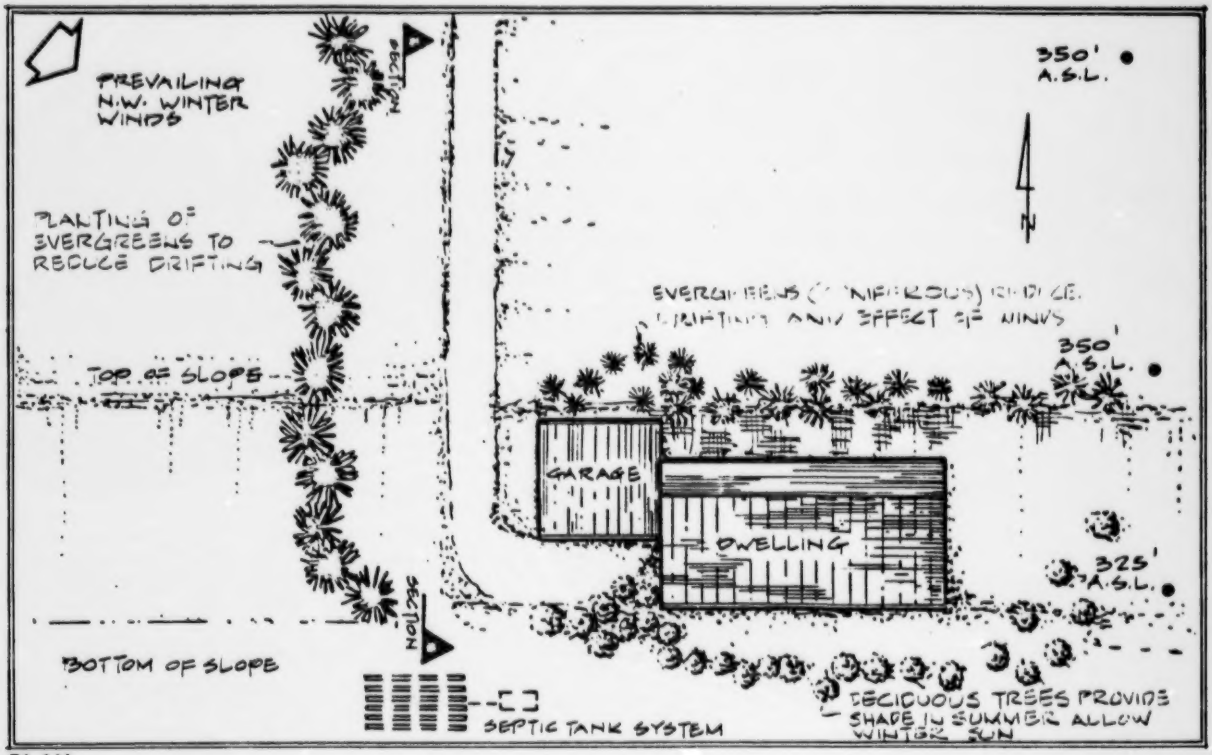
4.1 *Site Planning and Energy Conservation*

The primary principle of site design as it relates to the conservation of energy, is to counter or negate those aspects of climate which may add to the energy requirements of buildings, such as prevailing winter winds, while at the same time enhancing positive climatic factors such as solar radiation. More particularly, energy-conserving site design techniques utilize topography and vegetation to shield buildings in such a manner that space heating/cooling requirements are minimized and energy consuming ground operations, such as snowplowing, are also reduced (refer to Figures 5.1 and 5.2).

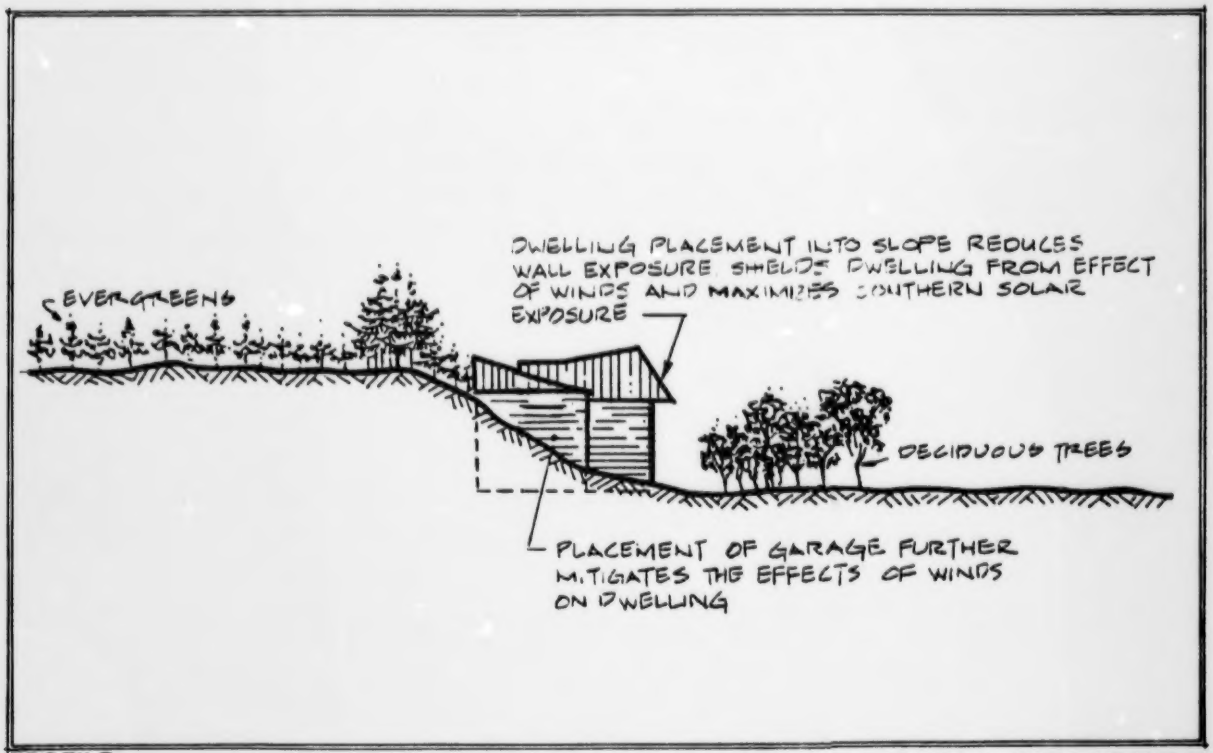
Rural development is generally characterized as being of a dispersed, low density nature and because of this feature dwelling units located in rural areas cannot normally realize the same benefits that exist in highly developed urban centres from shielding of other dwellings, buildings and structures. The spatial attributes of farming, for example, generally preclude consideration of increased density of farm dwellings. Counteracting this, certain negative aspects associated with higher development densities, such as


PREVAILING NW WINTER WIND DIRECTION.
TO FIELD
N
350' A.S.L.
FARM BUILDING PLACEMENT ALLOWS FOR LESS DRIFTING ON DRIVE THEREFORE LESS SURFACE CLEANING AND OPERATION.
WELL
POND: COOLING EFFECT IN SUMMER. ALLOWS FOR AIR/WATER HEAT EXCHANGE IN WINTER FOR SPACE HEATING PURPOSES. -SECONDARY RECREATION FUNCTION.
PLANTING OF EVERGREENS TO REDUCE DRIFTING THEREBY REQUIRING LESS SURFACE CLEANING.
DECIDUOUS TREES PROVIDE SHADE IN SUMMER. ALLOW WINTER SUN.
SOUTHERN DWELLING EXPOSURE MAXIMIZED.
SEPTIC TANK SYSTEM
HEDGEROW OR TREE ROW OF MIXED EVERGREEN DECIDUOUS TREES.
325' A.S.L.
CONCESSION ROAD

SITE DESIGN CONCEPT



PLAN


EVERGREENS
DWELLING PLACEMENT INTO SLOPE REDUCES WALL EXPOSURE SHIELDS DWELLING FROM EFFECT OF WINDS AND MAXIMIZES SOUTHERN SOLAR EXPOSURE
DECIDUOUS TREES
PLACEMENT OF GARAGE FURTHER MITIGATES THE EFFECTS OF WINDS ON DWELLING

PROFILE

SITE DESIGN CONCEPT

building shadows which impede the utilization of solar radiation for space heating purposes, are not experienced in the rural situation. Due to the generally low-density nature of development in rural areas, and the high proportion of transportation energy requirements, the importance of energy-conserving site planning practices becomes paramount. The fact that energy conscious site planning and design considerations have historically received only minor attention in rural areas is not representative of the nature and number of site planning opportunities which are present.

4.2 *Climatic Factors*

In assessing the manner by which effective rural site planning techniques can be utilized to conserve energy, a basic understanding of the influence of major climatological features upon space heating needs is required. Briefly, the major climatological factors affecting energy consumption are:[2]

- Solar Radiation - production of latent heat energy from striking objects and materials; can be effectively utilized for space heating purposes on both a passive and active (technology-assisted) basis; effectively utilized it can reduce space heat loads.

- Temperature - ambient air temperature affects the heating/cooling demand (heating or cooling degree days) for dwellings and other structures.

2 after Oke, T.R.- The Significance of the Atmosphere in Planning Human Settlements, 1976, Ottawa, Ontario.

- Wind - wind, depending upon its strength, serves to cause infiltration heat losses in buildings and structures, can ventilate buildings, affects wind loads on structures, and causes snow drifting and soil erosion; can be utilized to produce energy.

- Precipitation and Cloud Cover - when combined, precipitation and cloud cover reduce amounts of available solar radiation; precipitation affects loading requirements of structures, and causes dampness and icing of structures.

- Humidity - humidity is directly related to levels of human comfort especially in dwellings; humidity in extremes, which affect comfort negatively, promotes the use of energy consuming appliances (such as de-humidifiers and air conditioners).

When compared to urban areas, rural areas exhibit substantially different and unique climatic characteristics. The following table serves to point out some of the major climatic differences between urban and rural situations.

TABLE 4.1 RURAL CLIMATIC CONDITIONS EXPRESSED AS A PERCENTAGE MAGNITUDE OF BASE URBAN CONDITIONS

Climatic Parameter	ANNUAL	WINTER	SUMMER
Solar Radiation	+22%	+34%	+20%
Air Temperature	-1°c	-2°c	N/A*
Relative Humidity	+6%	+2%	N/A
Visibility (frequency)	+25%	+34%	N/A
Fog (frequency)	-60%	-100%	N/A
Wind Speed	+25%	+20%	+30%
Cloudiness	-8%	-5%	-15%
Rainfall	-14%	-13%	-15%
Snowfall	+-10%	+-10%	N/A
Thunder Storms	-16%	-5%	-30%
Pollution (volume)	-1000%	-2000%	-500%

*N/A - denotes information not available

Source: MODIFIED AFTER CHANG, 1974 and OKE, 1976

Briefly the major conclusions with respect to differences in rural and urban climates, from data in Table 5.1 are:

- solar radiation is more abundant within the rural setting, especially during the winter months when 34 percent more solar radiation is received in rural areas than in urban areas;

- ambient air temperatures experienced in rural areas are generally lower than in urban areas, especially during winter periods;

- the relative humidity is 6 percent greater, on an annual basis compared to urban areas;

wind speeds are an average of 25 percent greater in rural areas, on an annual basis, and more specifically are 20 percent greater during winter months and 30 percent greater during summer months;

It is readily apparent that site planning and design practices utilized in rural areas must reflect these climatic considerations in order to effectively contribute to energy conservation. Examples of specific types of measures which may be taken in this regard include:

- planting of treed wind breaks along lot boundaries, at right angles to the prevailing wind direction;

- construction of berms, or the utilization of natural topographical features to provide wind break and insulating effects;

- planting of deciduous trees to the south of dwelling unit to reduce summer heat gain from solar radiation;

- planting of coniferous trees to the north, west and east of buildings to reduce the effects of winter winds;

- placement of buildings in order to minimize effects (e.g. shadows) experienced by neighbouring structures, and also to attempt to group buildings, particularly non-residential structures in such a manner so as to reduce the effects of winds on residential buildings;

- grading or contour plans which would optimize access to solar radiation and minimize the effects of winds;

- placement of farm ponds, and other wind accentuating features, in order to ensure maximum building protection while at the same time allowing for summer cooling opportunities;

- placement of septic tanks, associated tile fields and wells in order to ensure that the nature and location of energy conserving, design-related features are not adversely affected;

4.3 Institutional Arrangements

In assessing the opportunities which exist in rural areas for implementing energy-conscious site planning it becomes obvious that a much greater degree of flexibility exists related to the arrangement of buildings and modifications of existing land forms and vegetation. As a result of substantially larger lot sizes, greater flexibility regarding building placement and the availability of undisturbed variations in topography provide greater opportunities for effective site planning in rural areas than in urban areas. These relative advantages serve to increase the opportunities to minimize the negative aspects of climate while accentuating the positive aspects.

The central issue is really how to create the awareness of the land user to energy saving opportunities. Careful site planning can effect a substantial level of energy conservation and to a certain extent this can offset the high transportation cost so characteristic of rural areas. Local governments have a vital role and two avenues exist within their powers to achieve public awareness:

.Official Plan Policies - Site Plan Control
.Zoning By-laws

4.4 Official Plan Policies

4.4.1 *Site Plan Control*

Powers over site plan control have been vested with all municipalities in the Province, both urban and rural, by virtue of the provisions of Section 40 of the Planning Act. However, problems in adopting and exercising powers with respect to site plan control do exist in rural areas for several reasons:

- a perception of over-regulation of development and a general disagreement with such measures;
- a general lack of understanding of how the various powers over site planning provided for in the Planning Act are to be utilized for the benefit of the individual
- the unavailability of qualified staff to guide and where necessary supervise site plan control measures;
- a common, and perhaps valid perception that site plan control powers were intended initially to be utilized by larger urban municipalities;

Quite obviously the objectives of site plan control legislation embrace many more areas of topical interest and concern than simply the conservation of energy. Properly utilized, however, site planning can lead to a more efficient and logical use of land, which could ultimately lead to a greater degree of energy conservation and efficiency.

To be effective, the principles of site plan control as they relate to energy conservation should be clearly stated in Official Plans so that all affected landowners can appreciate the intended purpose of these measures. Such statements should include:

- objectives and rationale;
- operative concepts, illustrated with the liberal use of graphics;
- benefits, costs and potential savings associated with measures to be employed.

Although site plan control policies are not requisite components of an Official Plan, the inclusion of such policies offers an avenue to provide energy efficient "opportunities" in conjunction with more traditional land development policies, thereby allowing for a better understanding of the inter-relationships which exist. In addition to containing objectives and the rationale for the adoption of energy-conscious site planning control principles, the Official Plan should also define how development control is to be administered; types or classes of development affected by site plan control; information required from the developer; and a list of effective site planning initiatives.

With respect to the dissemination of information regarding the operative concepts of energy-conserving site plan control techniques and associated benefits, consideration could be given to the production of a small information brochure or booklet. As well as containing the policies of the Official Plan with respect to site plan control and design, such an information package could be issued to prospective developers at the time of application for a building permit. This information could lead to the re-consideration of development plans and the eventual introduction of energy-conserving design features in development proposals.

4.5 *Zoning By-Laws*

While site plan control has a potentially important role with respect to the consideration of on-site energy conservation design features, a municipality's zoning by-law also has a significant potential impact. The nature of the power conferred upon municipalities by the Planning Act with respect to zoning by-laws includes powers over numerous matters which are applicable within the context of energy conservation and land use planning.

More specifically, by-laws may be passed by councils of municipalities which affect the following energy-related aspects of land development:

- type of construction;
- height, bulk, location, size, floor area, spacing, external design, character and use of buildings;
- minimum frontage and depth of land parcels;
- minimum area of land parcels;
- maximum amount of building coverage on a parcel of land;
- development density within the municipality;
- prohibition of the use of land;
- prohibition of the erection or use of buildings or structures.

Within the context of these broad powers over the use of land, it is quite apparent that a zoning by-law has many implications on site-related aspects of land development. Such matters as the height, location, size, floor area and spacing and use of buildings obviously have important implications on energy consumption related to land use. As a

result of their potential importance with respect to energy conservation, regulations included within a zoning by-law should be examined to ensure their relevance and effectiveness in promoting the efficient use of energy. For regulations which may be somewhat dated, attempts should be made to determine whether they contain any impediments to the efficient use of energy.

5.0 LAND USE PLANNING CONSIDERATIONS

5.1 *Considerations for Agriculturally-based Townships in Southern Ontario*

Energy consumption efficiencies can be substantially influenced by clustering non-farm development in hamlets or nodes and by ensuring that these centres are provided with services which are consistent with their size and scale. By clustering development, substitution advantages exist for the introduction of advanced tecnnologies such as: methane generating centres; heat exchange systems; and wind shielding. Furthermore, transportation linkages to external service centres or work opportunities should be considered in the siting of these centres so that transportation energy costs are reduced and the possibility for public transit systems or private co-operative arrangements are optimized.

It is acknowledged that the trend toward increased size and specialization of farming operations with its concomitant effect of declining population concentration may adversely influence the feasibility of hamlets in fulfilling a service function for a changing agricultural area. In agriculturally oriented townships where population densities are extremely low and maximum farm sizes prevail, the possibility of farm service centres may not be practical financially or otherwise. Regardless it is apparent that for most areas, non-farm development should be discouraged, and energy conserving efforts focused on the farm unit, in terms of siting, and substitution opportunities for the individual farm unit.

The preceding observations suggest several planning initiatives which could be undertaken at a township or county

level. Municipalities may wish to consider the following areas of policy and regulation development:

The Official Plan

a) Baseline energy consumption requirements for the township or region may be established so that the effects of alternative energy strategies and development proposals may be assessed.
b) Strategies may be formulated which include consideration of control and limitation of non-farm development to clusters where substitution and transportation energy-saving advantages exist.
c) General policies may be incorporated such that site-energy efficiencies may be achieved through implementing zoning by-law(s). These policies should incorporate such considerations as: building scale and orientation; shielding opportunities through maintenance of natural buffers or adjacent structures (the farm compound).
d) Policies pertaining to site plan control including the manner of administration, and illustrated conservation concepts, may be incorporated.
e) The implementation strategy may be defined so that a unified program of public information and education is reinforced by municipal development policies

The Zoning By-law

a) By-laws may be modified to incorporate regulations regarding buffer locations, structure height and location, wind and solar orientation.

Site Plan Control Guidelines

b) Subject to the municipality's development control philosophy, site planning may or may not be implemented in a prescriptive and rigorous manner including the development of a set of municipality-specific guidelines. Alternatively if the municipality is not in a position to effectively administer site plan control it may wish to adopt an information/education posture in which information regarding conservation-oriented site planning measures may be dispersed in a booklet-type format prior to the issuance of a building permit.

Severance Applications

a) Policies could be developed by the municipality which require energy considerations to be incorporated as part of the site design submission and a condition of the severance being granted. More importantly, strategies could be developed to restrict non-farm development to within certain areas of the municipality thereby restricting severances and non-farm growth to certain areas.

5.2 *Considerations for Recreation-based Townships in Central Ontario*

A review of the energy requirements for the recreation-oriented township concludes that up to 90% of all energy consumption is related to travel and that strip development is a highly inefficient land use form. Given that the bulk of all recreation lakes are already utilized by strip cottage development future changes such as new subdivision development should be oriented into clusters. These clusters should

be provided with a maximum number of seasonal services and each cluster should be located as close as possible to major transportation facilities.

Observations of the test models suggest that a threshold exists in terms of year round development whereby increases in the percentage of permanent residences to approximately 40 percent (including conversion of seasonal residences), negates all other energy efficiencies gained through innovative land use planning alternatives. It is therefore evident that extreme caution should be exercised in the degree to which year round development, including conversions, is encouraged or facilitated in rural townships. Not only does there appear to be a hidden energy inefficiency, but the added expenditures of remote and/or scattered educational busing requirements, snow removal, fire protection, mail delivery, garbage collection, and so on, all compound the energy demand. All must be carefully scrutinized before permitting such development. The economic base of the rural recreation township rarely provides the substance for supporting these demands.

Similar to the agriculturally-oriented township, policies could be developed for incorporation in Official Plans and Zoning By-laws to guide development in the recreation based township. Municipalities may wish to consider the following areas of policy and regulation development:

The Official Plan

a) Baseline energy requirements for the township may be established so that alternative energy strategies may be developed.

b) All new development could be directed into clusters where seasonal shopping and other services can be located and where public services such as road maintenance and garbage collection can be provided on a communal basis.

To this end, Official Plan background studies and associated policies could provide the basis for "Limited Service Residential" policies whereby the random location of permanent residences in recreation based townships is discouraged. Official Plan land use schedules may be used to designate areas for clustered seasonal development while policies could attempt to discourage both the conversion of cottages to permanent or seasonal dwellings in a strip-like fashion throughout the township.

c) Growth could be incremental, allowing for rounding-off of sporadically developed areas, prior to the development of new areas.

The Zoning By-law

a) Subject to Official Plan policies, By-laws could be modified to incorporate possible restrictions on permanent occupancy,as well as to promote energy conserving development considerations related to wind and solar access, shadowing, etc.

Severance Applications

b) Municipalities could consider development of policies regarding the location of severances and possible restriction in certain recreation areas.

5.3 *Considerations for Renewable Resource-based Townships*

Test observations indicate that renewable-resource based townships offer the least opportunity for significant per capita energy conservation via the implementation of innovative land use planning techniques. As a result of this finding, consideration of site design alternatives and substitution technologies are of the greatest significance in effecting energy conservation in those townships which are located in northern Ontario.

Since a substantial number of resource based communities in this Province have not participated in full land use planning programmes to date, it is suggested that consideration be given to the development of Official Plans for these communities as a prerequisite to effective energy conservation alternatives. Such municipalities may wish to consider the following areas of policy and regulation development:

- *The Official Plan*

  The Official Plan is the appropriate vehicle for the development of Limited Service Residential areas which can be subsequently regulated in Zoning By-laws. The effect of this procedure in resource-based townships would be to ensure that further energy inefficiencies are not accrued in the community as a result of indiscriminate development in relatively remote parts of the municipality. The Official Plan may also suggest stringent site plan policies (which ultimately would be implemented in some form of a site plan by-law).

- *The Zoning By-law*

  By-laws may be formulated, or modified depending upon the level of planning involvement, to restrict development to certain areas, and also to provide for regulations related to structure height and locations, wind and solar orientation.

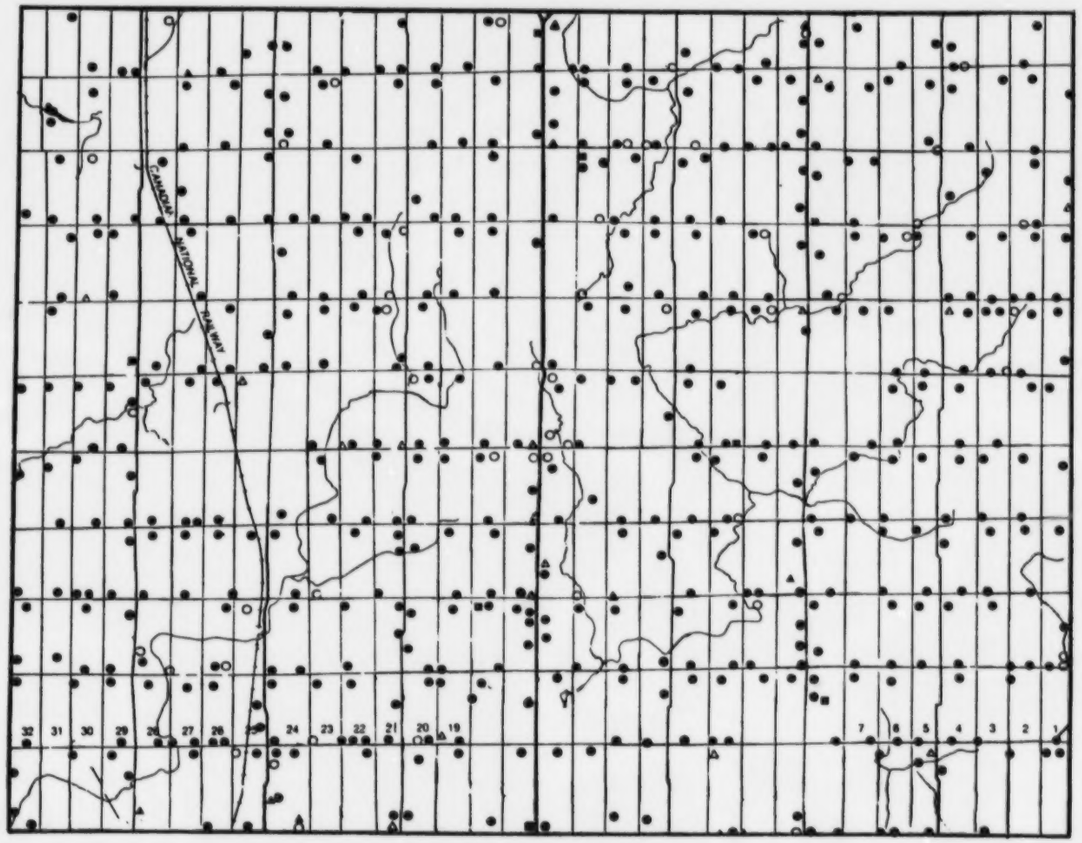
- *Site Plan Control Guidelines*

  Although there are administrative considerations, site planning measures would appear to have many particularly important rammifications on energy consumption in northern areas due to a variety of climatic considerations. The municipality may wish to consider incorporation of site planning policies in the official plan or a set of separate guidelines.

APPENDIX I

Graphic Portrayal of Baseline Models and Tests

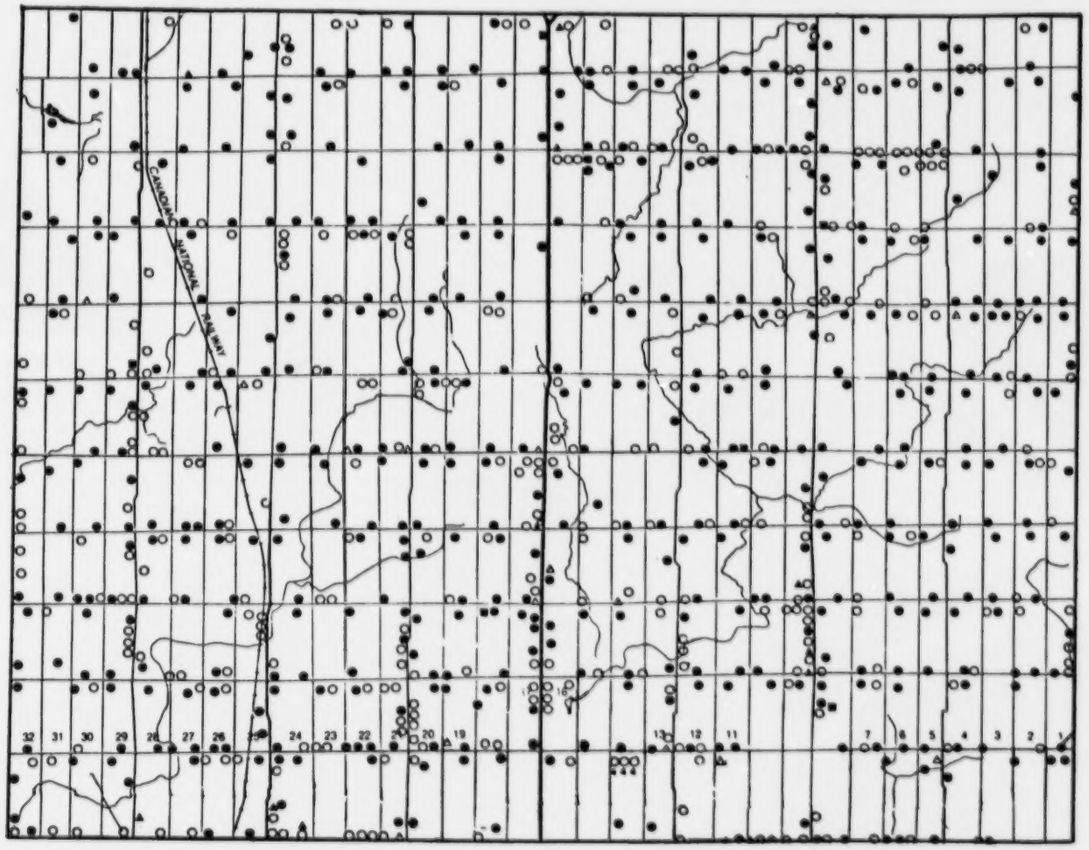
AGRICULTURAL MODEL-BASELINE



0 1 2 KILOMETRES

0 1 2 MILES

- INDUSTRIAL
- NON-FARM (RESIDENTIAL)
- FARMS
- COMMERCIAL
- INSTITUTIONAL

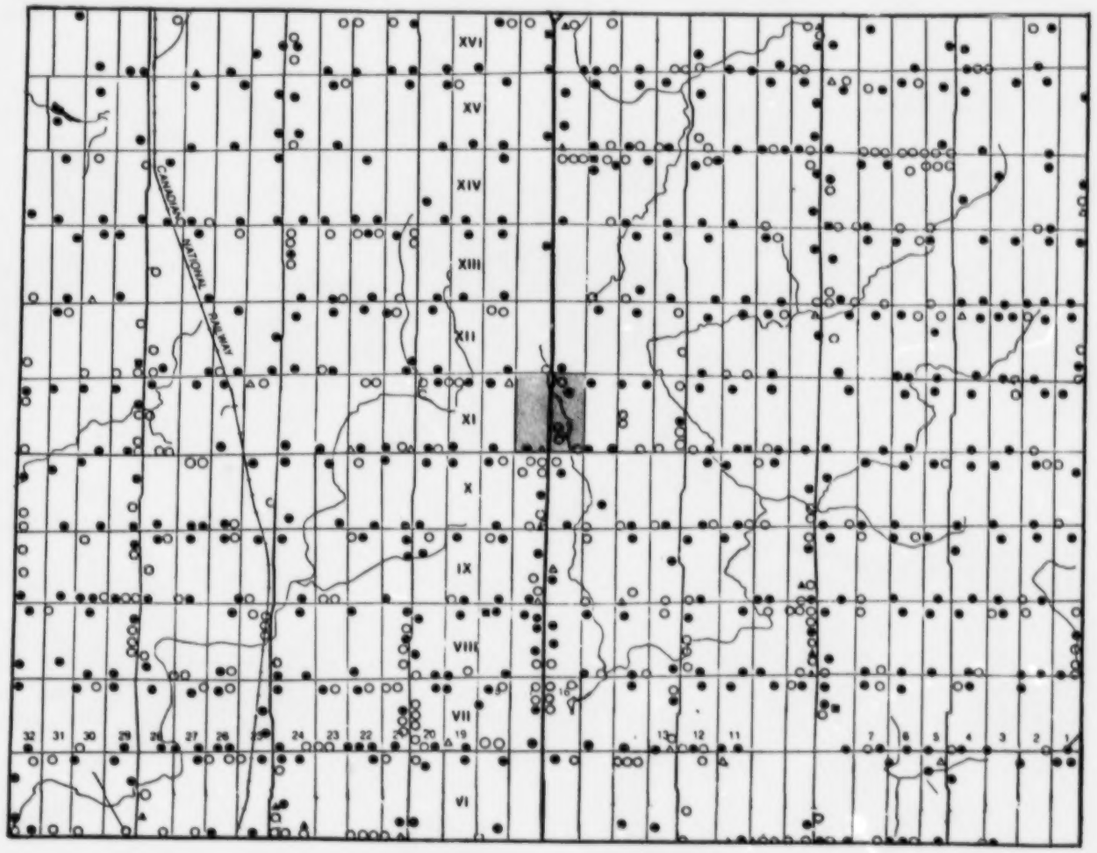


AGRICULTURAL MODEL-TEST 1
(INCREASE NON-FARM RESIDENTIAL)

0 1 2 KILOMETRES
0 1 2 MILES

- INDUSTRIAL
- NON-FARM (RESIDENTIAL)
- FARMS
- COMMERCIAL
- INSTITUTIONAL

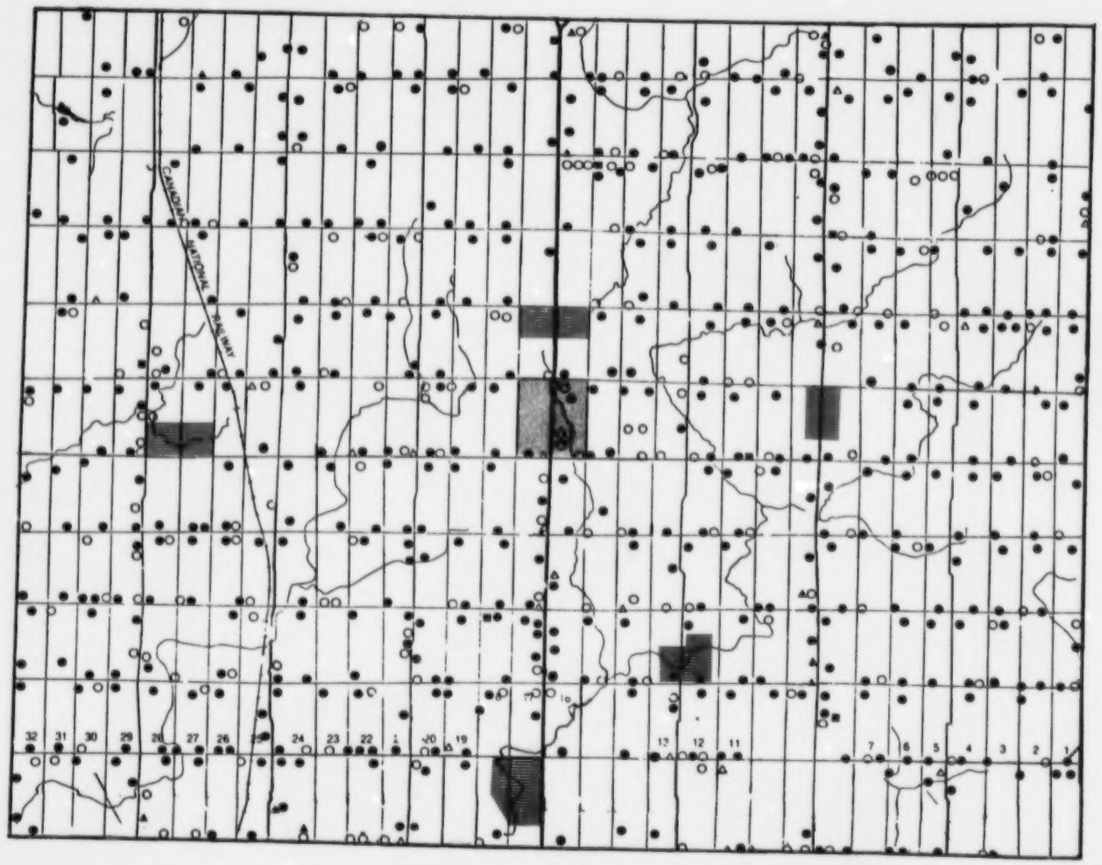
AGRICULTURAL MODEL-TEST 2
(CENTRALIZED HAMLET AND REPEAT 1)



0 1 2 KILOMETRES
0 1 2 MILES

- HAMLET
- INDUSTRIAL
- NON-FARM (RESIDENTIAL)
- FARMS
- COMMERCIAL
- INSTITUTIONAL

MacLaren Plansearch



AGRICULTURAL MODEL-TEST 3

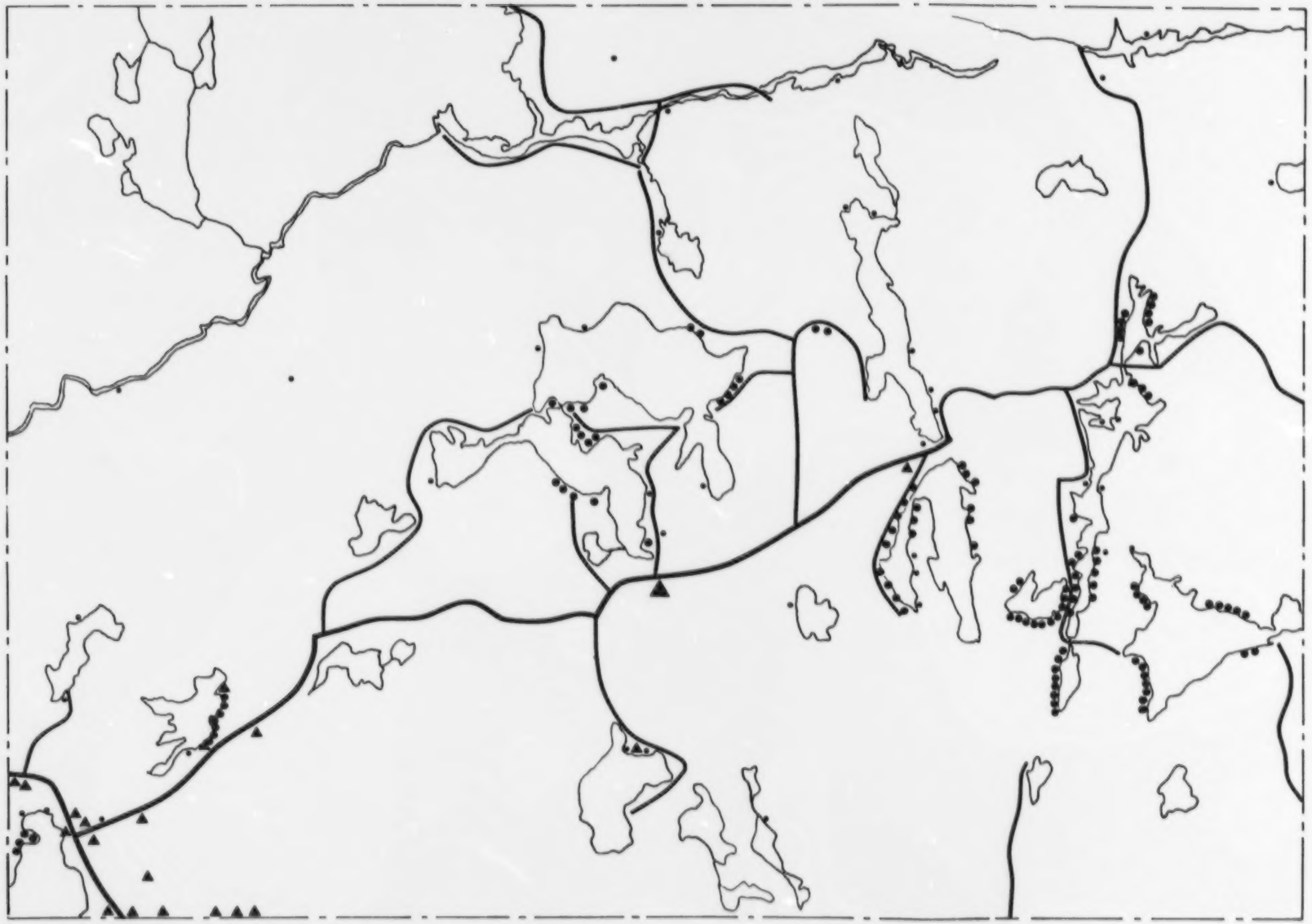
(REPEAT TESTS 1 & 2 & CLUSTERED NON-FARM DEVELOPMENT)

0 1 2 KILOMETRES

0 1 2 MILES

- NON-FARM (CLUSTERED)
- HAMLET
- INDUSTRIAL
- NON-FARM (RESIDENTIAL)
- FARMS
- COMMERCIAL
- INSTITUTIONAL

RECREATION MODEL-
BASELINE

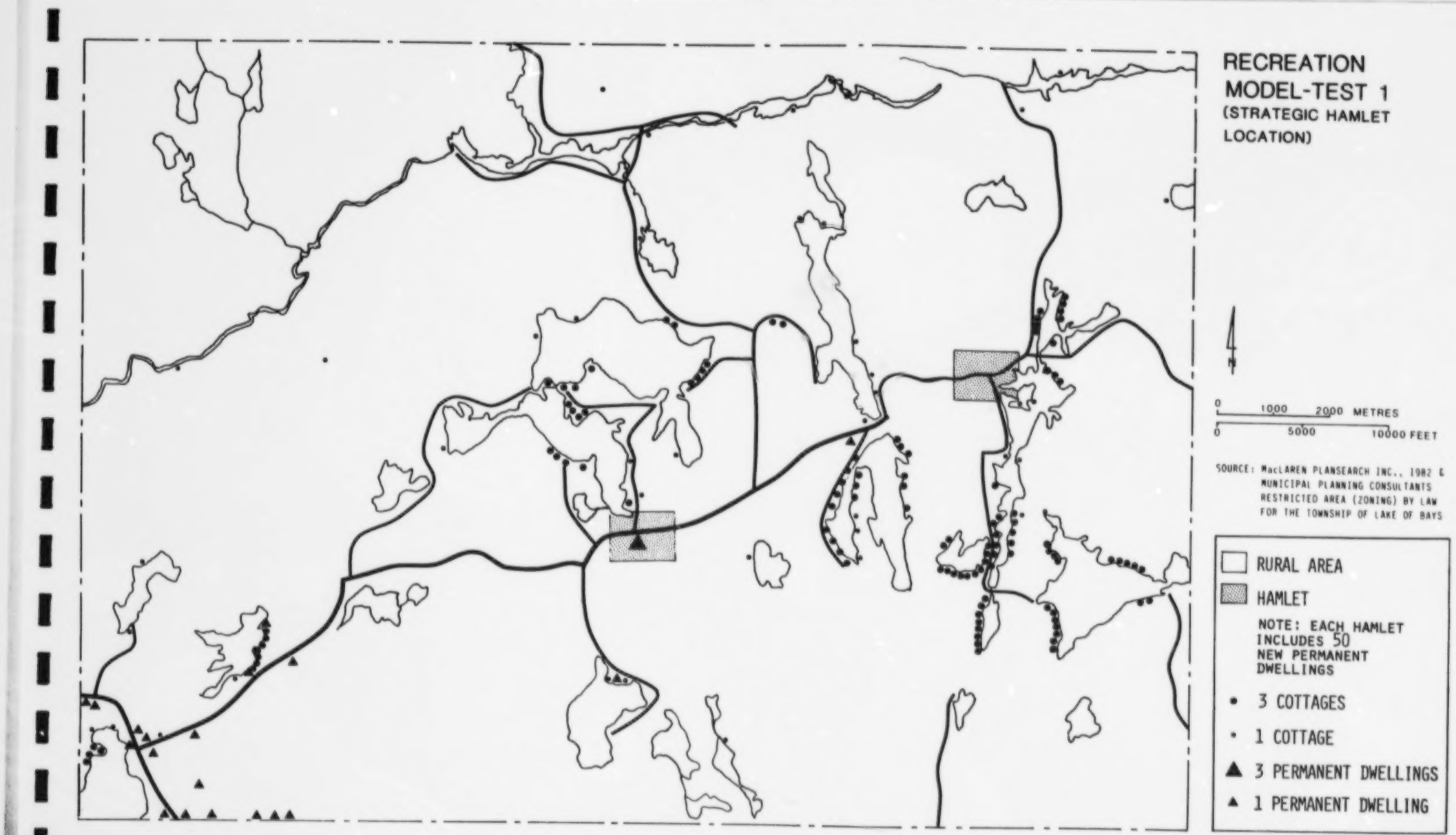


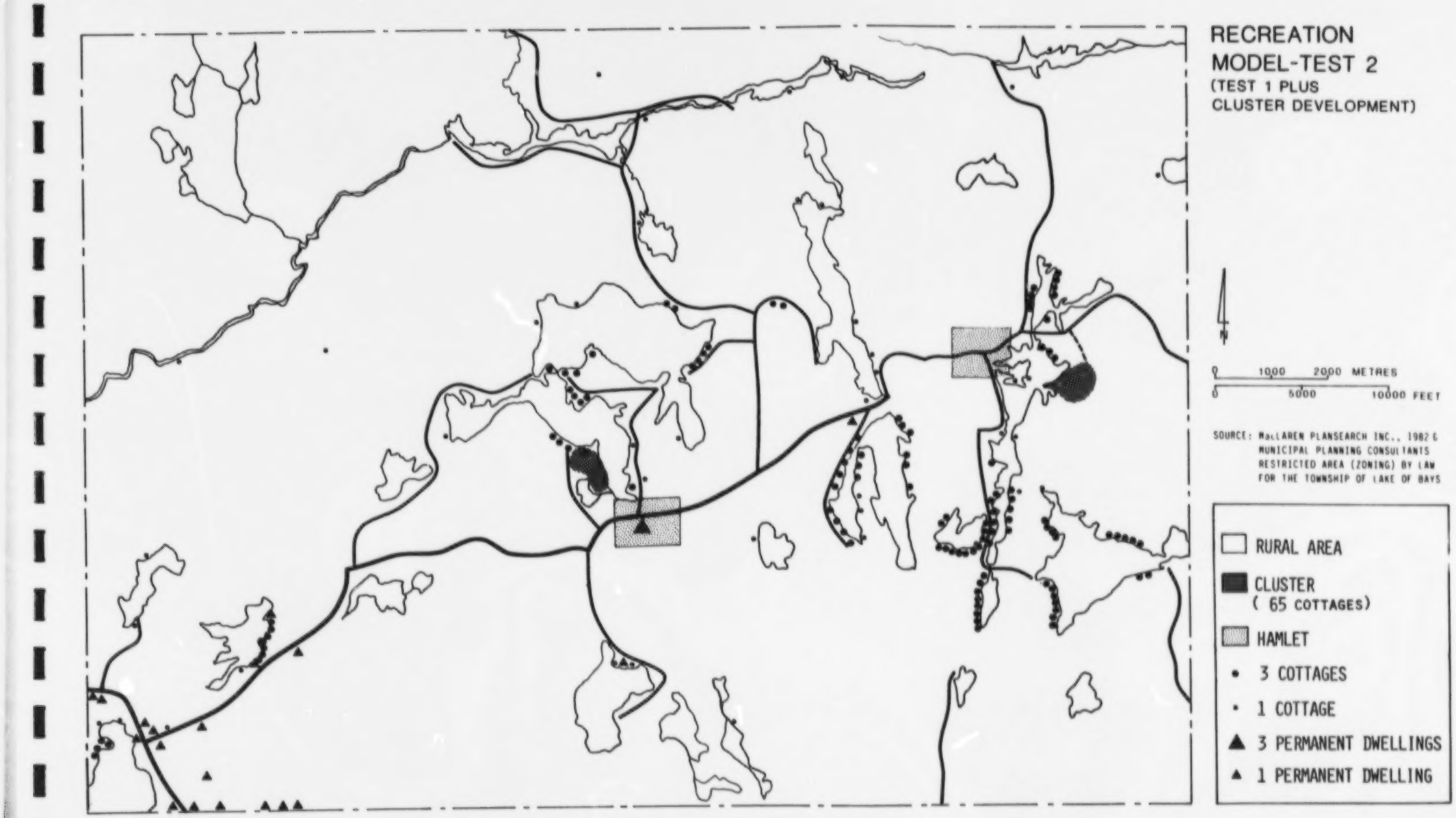
0 1000 2000 METRES

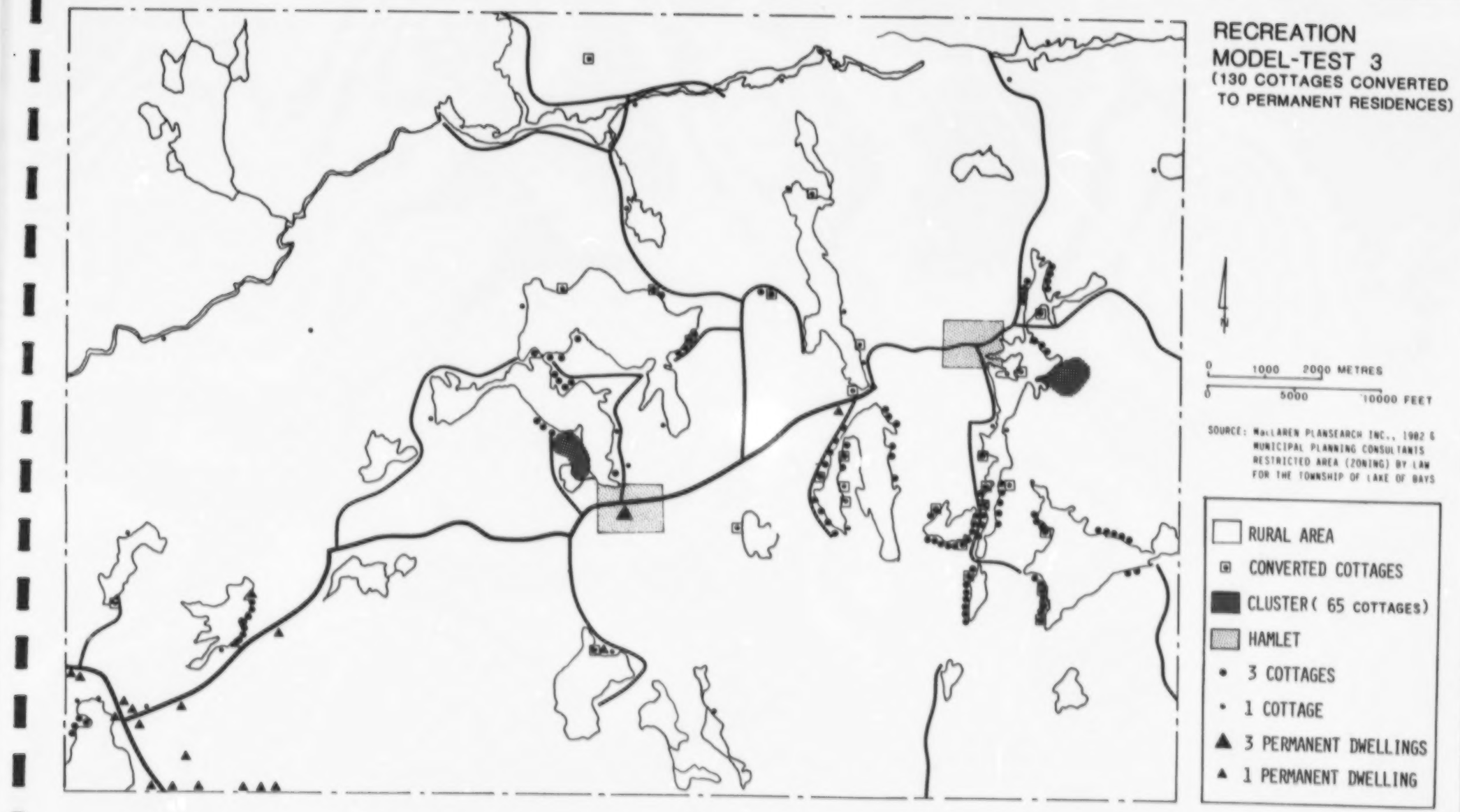
0 5000 10000 FEET

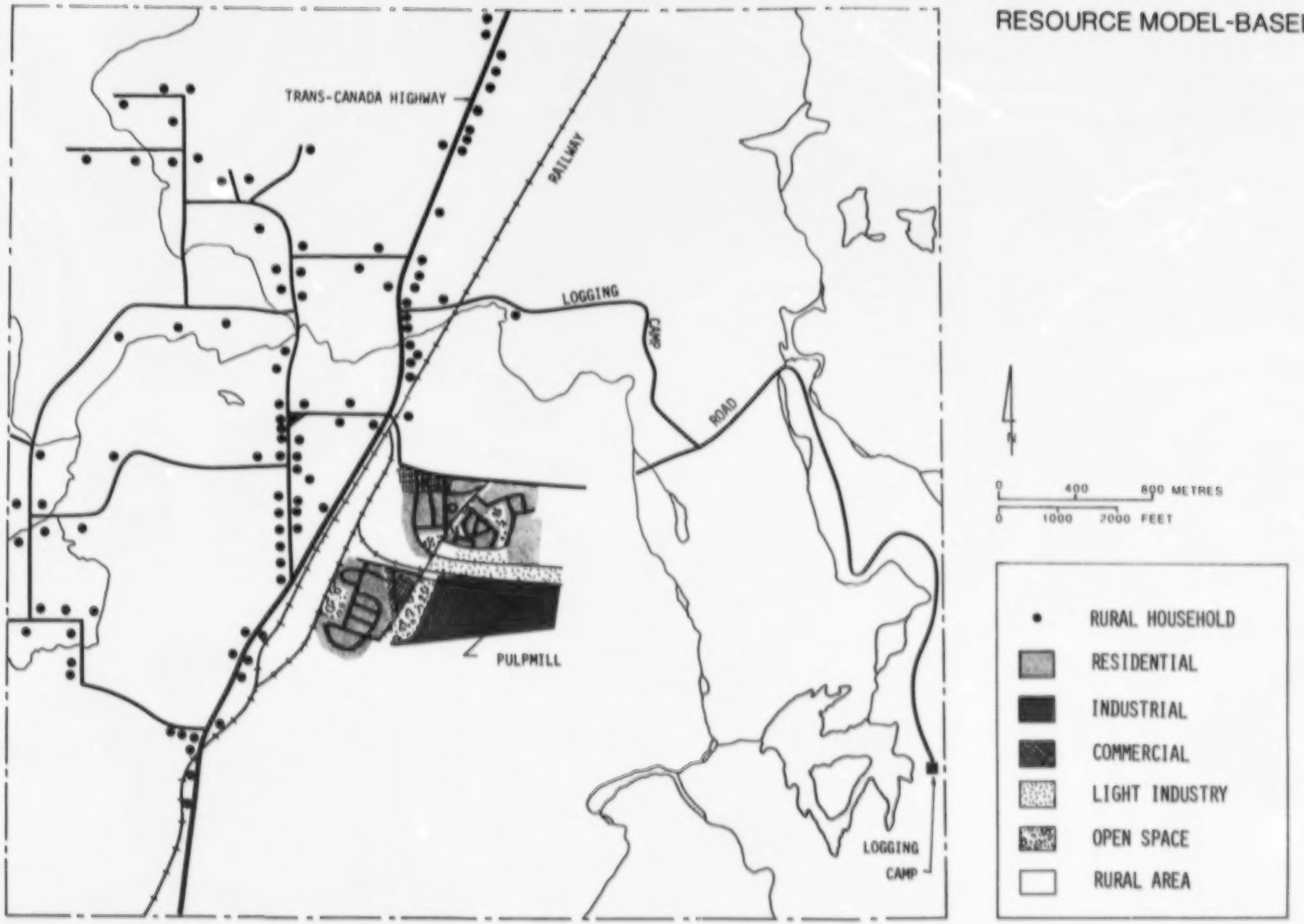
SOURCE: MacLAREN PLANSEARCH INC., 1982 &
MUNICIPAL PLANNING CONSULTANTS
RESTRICTED AREA (ZONING) BY-LAW
FOR THE TOWNSHIP OF LAKE OF BAYS

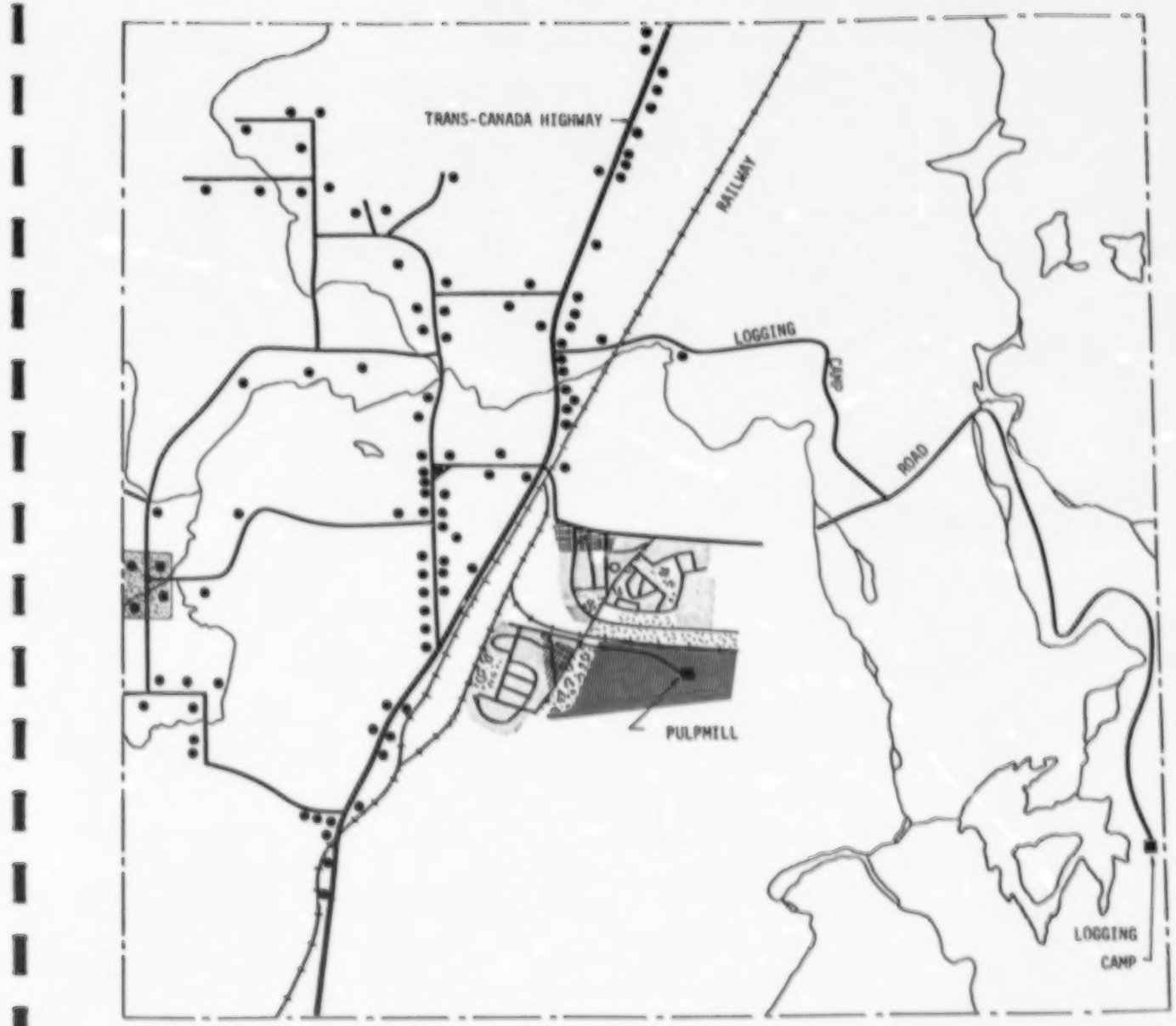
- RURAL AREA
- 3 COTTAGES
- 1 COTTAGE
- 3 PERMANENT DWELLINGS
- 1 PERMANENT DWELLING


RECREATION
MODEL-TEST 1
(STRATEGIC HAMLET
LOCATION)
0 1000 2000 METRES
0 5000 10000 FEET
SOURCE: MacLAREN PLANSEARCH INC., 1982 &
MUNICIPAL PLANNING CONSULTANTS
RESTRICTED AREA (ZONING) BY LAW
FOR THE TOWNSHIP OF LAKE OF BAYS
RURAL AREA
HAMLET
NOTE: EACH HAMLET
INCLUDES 50
NEW PERMANENT
DWELLINGS
3 COTTAGES
1 COTTAGE
3 PERMANENT DWELLINGS
1 PERMANENT DWELLING


RECREATION
MODEL-TEST 2
(TEST 1 PLUS
CLUSTER DEVELOPMENT)
1000 2000 METRES
0 5000 10000 FEET
SOURCE: MacLAREN PLANSEARCH INC., 1982 &
MUNICIPAL PLANNING CONSULTANTS
RESTRICTED AREA (ZONING) BY LAW
FOR THE TOWNSHIP OF LAKE OF BAYS
RURAL AREA
CLUSTER
(65 COTTAGES)
HAMLET
3 COTTAGES
1 COTTAGE
3 PERMANENT DWELLINGS
1 PERMANENT DWELLING


RECREATION
MODEL-TEST 3
(130 COTTAGES CONVERTED
TO PERMANENT RESIDENCES)
N
0 1000 2000 METRES
0 5000 10000 FEET
SOURCE: MacLAREN PLANSEARCH INC., 1982 &
MUNICIPAL PLANNING CONSULTANTS
RESTRICTED AREA (ZONING) BY LAW
FOR THE TOWNSHIP OF LAKE OF BAYS
RURAL AREA
CONVERTED COTTAGES
CLUSTER(65 COTTAGES)
HAMLET
3 COTTAGES
1 COTTAGE
3 PERMANENT DWELLINGS
1 PERMANENT DWELLING


RESOURCE MODEL-BASELINE
TRANS-CANADA HIGHWAY
RAILWAY
LOGGING
ROAD
PULPMILL
LOGGING
CAMP
N
0 400 800 METRES
0 1000 2000 FEET
RURAL HOUSEHOLD
RESIDENTIAL
INDUSTRIAL
COMMERCIAL
LIGHT INDUSTRY
OPEN SPACE
RURAL AREA



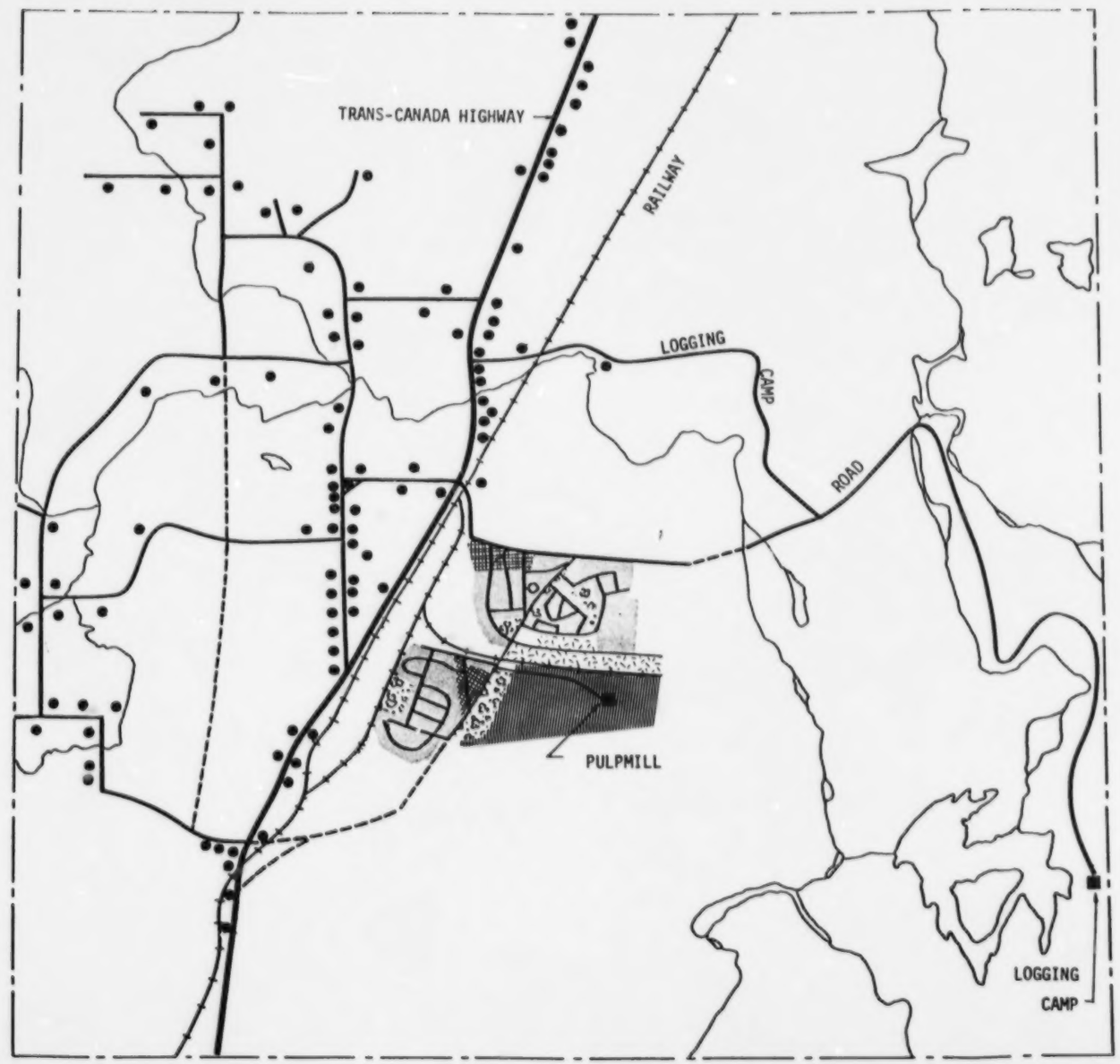
RESOURCE MODEL-TEST 1

(INTRODUCTION OF HAMLET IN RURAL AREA WITH 50 NEW HOUSEHOLDS)

0 400 800 METRES

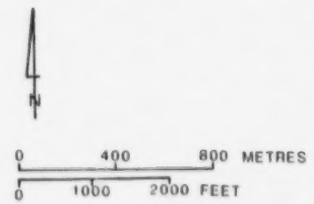
0 1000 2000 FEET

- HAMLET
- RURAL HOUSEHOLD
- RESIDENTIAL
- INDUSTRIAL
- COMMERCIAL
- LIGHT INDUSTRY
- OPEN SPACE
- RURAL AREA

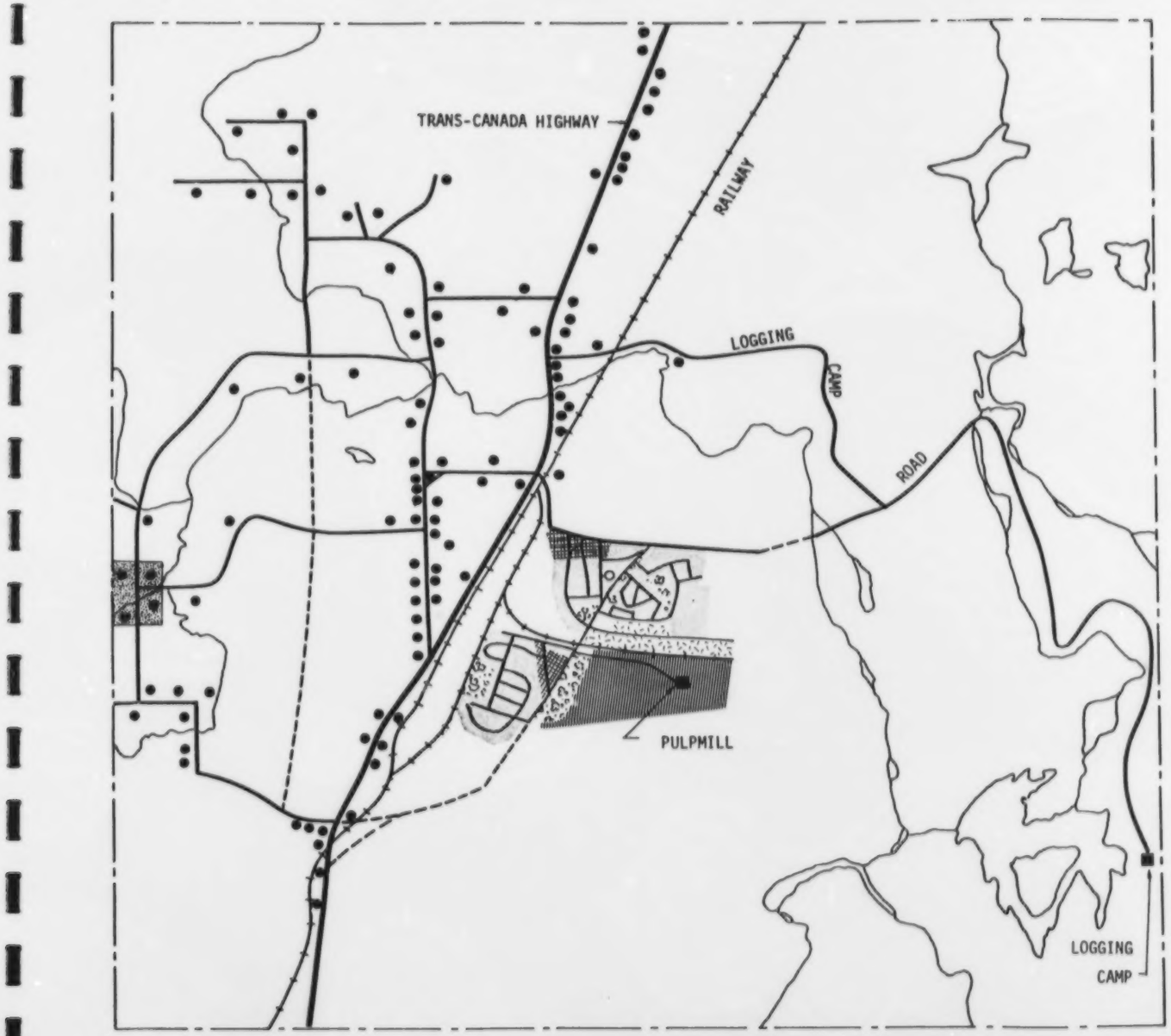


RESOURCE MODEL-TEST 2

(IMPROVEMENT TO TOWNSHIP ROAD NETWORK)



- NEW ROADS
- RURAL HOUSEHOLD
- RESIDENTIAL
- INDUSTRIAL
- COMMERCIAL
- LIGHT INDUSTRY
- OPEN SPACE
- RURAL AREA



RESOURCE MODEL-TEST 3

(TEST 1 PLUS TEST 2)

N

0 400 800 METRES

0 1000 2000 FEET

- NEW ROADS
- HAMLET
- RURAL HOUSEHOLD
- RESIDENTIAL
- INDUSTRIAL
- COMMERCIAL
- LIGHT INDUSTRY
- OPEN SPACE
- RURAL AREA

APPENDIX II

Baseline Model and Test Assumptions

1.0 *The Agricultural Baseline Model*

Land Use

- Agriculture is the dominant economic activity.
- The township does not contain any hamlets or major clusters of development offering any commercial, educational or recreational functions.

Area and Unit Size

- The total township area is 20,000 hectares (50,000 acres).
- The average farm size is approximately 40 hectares (100 acres).

Residential Development and Population

- The total number of farm residences is 500.
- The total number of non-farm residences is approximately 50.
- The average number of persons per farm is 4.0, including hired help, resulting in a farm population of 2,000 persons.
- The average number of persons per non-farm residence is 3.0, thereby creating a non-farm residential population of 150, and a total township population of 2,150.

Travel Patterns

- The location of employment for farm residents is on the farm while the location of employment for non-farm residents is assumed to be outside of the township in a

nearby urban centre located to the south of the "model" township.

- All non-employment related trips originating from farm and non-farm properties alike extend outside of the townsnip.

Residential Space Heating Requirements

- The form and structure of farm residences is assumed to be of a two-storey variety with an average floor area of 185 square metres (2000 square feet), excluding basement areas, and with associated space heating requirements of approximately 130,000 MJ per unit per annum, with forced air oil heating (furnace efficiency of 60 percent).
- The form and structure of non-farm residences is assumed to be of a one-storey ranch variety, reflecting more recent construction, with an average floor area of 140 square metres (1,500 square feet), excluding basement area and with associated space heating requirements of approximately 105,000 MJ per unit per annum, with forced air oil heating (furnace efficiency of 60 percent).

1.1 *Non-Farm Residential Growth (Test A1)*

Objective

- The objective of this test is to explore changes in energy consumption from the baseline model, associated with a growth in scattered non-farm residential development.

Land Use

- Agriculture remains the dominant primary economic and land use activity.

- A significant amount of scattered non-farm residential development (250 residences) has, however, been added.
- The township, as in the agricultural baseline model, does not yet contain hamlets or major clusters of development offering commercial, educational or recreational services.

Residential Development and Population

- The total number of non-farm residences has been increased from 50 to 300 in order to demonstrate the impact on energy consumption of increased amounts of this type of development.
- The farm population remains at 2,000 persons. However, the non-farm population increases to 900 for a total township population of 2,900 which represents an increase in total population of 750 over the agricultural baseline model.

1.2 *Addition of Hamlet (Test A2)*

Objective

- The objective of test A2 is to examine the effect on energy consumption of a centrally-located hamlet offering basic urban services in the areas of farm and family service shopping, recreation and education.

Land Use

- Agriculture remains the dominant land use activity.
- A centrally-located hamlet is added to the township to provide commercial, recreation and education services.

- The township experiences a greater degree of non-farm residential development than in Test A2.

Residential Development and Population

- The total number of non-farm residences has been increased by 25 over test A1 to 325 in order to reflect residential development associated with the centrally located hamlet.
- The farm population remains at 2,000 persons. However, the non-farm population increases to 975, for a total township population of 2,975 which represents an increase in total population of 825 over the agricultural baseline situation, and 75 over test A1.

Travel Patterns

- All family service and farm related shopping trips, formal recreation trips and education-related trips are to the centrally-located hamlet.
- All non-farm, employment-oriented travel is assumed to be to destinations located outside of the township.

1.3 *Hamlet and Clustered Non-Farm Development (Test A3)*

Objective

- The objective of test A3 is to evaluate the effects on energy consumption of clustered non-farm residential development in the rural portion of the township, outside of the hamlet.

Land Use

- Test A3 builds upon test A1 - Non-Farm Residential Growth and test A2 - Hamlet.

- 25 additional non-farm residences have been added for a total of 350 non-farm residences and in addition, approximately 20 percent of all non-farm residential development is assumed to be organized on a clustered or nodal basis.

Residential Development and Population

- The farm population remains at 2,000 persons. However, the non-farm population increases to 1,050 for a total township population of 3,050, representing an increase in total population of 900 over the baseline model, 150 over test A1 and 75 over test A2.

Travel Patterns

- Travel patterns are as per test A2.

SUMMARY OF ASSUMPTIONS

AGRICULTURAL BASELINE MODEL AND TESTS

Characteristics	ASSUMPTIONS Agricultural Baseline Model	Test A1 Non-Farm Residential Growth	Test A2 Addition of Hamlet	Test A3 Hamlet and Clustered Non-Farm Development
1. Land Use Pattern Considerations				
.land use characteristics	agricultural land use activity is dominant, minor non-farm development	agriculture dominant increased non-farm development	agriculture dominant increased non-farm development addition of centrally located hamlet	agricultural dominant increased non-farm development 20% of non-farm development in clusters centrally located hamlet
.total township area	20,000 hectares	20,000 hectares	20,000 hectares	20,000 hectares
.average farm area & size	40 hectares	40 hectares	40 hectares	40 hectares
.# farm area & size	500 farm residences	500 farm residences	500 farm residences	500 farm residences
.# of non-farm residences	50 non-farm residences	300 non-farm residences	325 non-farm residences	350 non-farm residences
.total # of residences	550 total residences	800 total residences	825 total residences	850 total residences
2. Demographic Characteristics				
.farm population (4.0 pers/res.)	2,000	2,000 farm	2,000	2,000 farm
.non-farm population (3.0/res.)	150	900 non-farm	975 non-farm	1,050 non-farm
.total township population	2,150	2,900	2,975	3,050

Summary of Assumptions - Agricultural ..... continued ...../2

Characteristics	Agricultural Baseline Model	ASSUMPTIONS Test A1 Non-Farm Residential Growth	Test A2 Addition of Hamlet	Test A3 Hamlet and Clustered Non-Farm Development
3. Travel Patterns	all trips to urban centre outside of township	all trips to urban centre outside of township	all trips to central hamlet except for non-farm work	all trips to central hamlet except for non-farm work
Journey from farm or farm-related to:				
.farm to commercial centres	2 return trips per working day	2 return trips per working day	2 return trips per working day	2 return trips per working day
.family service shopping	1 return trip every 2 days	1 return trip every 2 days	1 return trip every 2 days	1 return trip every 2 days
.education	1 return trip per school day	1 return trip per school day	1 return trip per school day	1 return trip per school day
.recreation	2 return trips per week	2 return trips per week	2 return trips per week	2 return trips per week
Journey from non-farm residence to:				
.place of work	1 return trip per working day	1 return trip per working day	1 return trip per working day	1 return trip per working day
.family service shopping	1 return trip every 2 days	1 return trip every 2 days	1 return trip every 2 days	1 return trip every 2 days
.education	1 return trip per school day	1 return trip per school day	1 return trip per school day	1 return trip per school day
.recreation	2 return trips per week	2 return trips per week	2 return trips per week	2 return trips per week

Summary of Assumptions - Agricultural ..... continued ...../3

Characteristics	Agricultural Baseline Model	ASSUMPTIONS Test A1 Non-Farm Residential Growth	Test A2 Addition of Hamlet	Test A3 Hamlet and Clustered Non-Farm Development
4. Vehicles				
	all vehicles are North American style (7.0 km/litre)	same as baseline model	same as baseline model	same as baseline model
	school bus to each residence (1.8 km/litre) 10 buses required	14 buses	14 buses	14 buses
5. Maintenance				
	3 times per winter for snow removal and sanding (15 week season) (1.8 km/litre)	3 times per winter	3 times per winter	3 times per winter
6. Residential Space				
Heating Requirements				
Average Farm Dwelling Size	two storey, 185 square metres	two storey, 185 square metres	two storey, 185 square metres	two storey, 185 square metres
Average Space Heating Requirement (pa. annum)	150,000 MJ	150,000 MJ	150,000 MJ	150,000 MJ
Average Non-Farm Dwelling Size	ranch, 140 square metres	ranch, 140 square metres	ranch, 140 square metres	ranch, 140 square metres
Average Space Heating Requirement (per annum)	105,000 MJ	105,000 MJ	105,000 MJ	105,000 MJ

2.0 *The Recreation Baseline Model*

Land Use

- Recreation, in the form of seasonal, lake and river-oriented cottage activity is the predominant land use activity (seasonal referring to the May-October period).
- A limited amount of agricultural activity, utilizing approximately 5 percent of the Township's land base, is recognized and such activity constitutes the only form of land use conducted on a year-round basis.
- Large tracts of "vacant" land exist within the township which are occupied by natural vegetation, rock outcrops and water bodies.
- The township does not contain any major clusters of development offering any commercial, educational or recreational functions, although small and sporadically-located commercial uses, such as marinas, do exist within the township which serve very localized needs.

Area and Unit Size

- The total township area is approximately 29,100 hectares (72,000 acres).

Residential Development and Population

- The total number of seasonal or cottage residences is 375, which are primarily organized in a strip-fashion along waterfronts.
- The total number of permanent farm dwellings is approximately 25, scattered throughout the municipality to reflect the dispersed spatial distribution of pockets of usable agricultural land and grazing areas.

- The average number of persons per cottage is 4.2, thereby creating a seasonal population of 1,575 residents.
- The average number of persons per farm dwelling is 3.0, thereby creating a permanent population of approximately 75. The total population during the period May - October is 1,650 and during the period November - April the total population is 75.

Travel Patterns

- All trips, originating from "seasonal" and "permanent" properties alike, extend outside of the township to a nearby urban centre which offers commercial, educational and formal recreation services.
- For seasonal residents, no employment-related commuting occurs either within or outside of the township.

Residential Space Heating Requirements

- The form and structure of seasonal, cottage residences is of a one-floor variety with an approximate average floor area of 85 square metres (800 square feet), the space heating requirements of which are met by wood heating systems (e.g., wood stoves, fireplaces) and electrical or gas space heating units on a predominantly summer oriented basis of operation. On this basis the space heating needs of cottage residences, including minor amounts of winter time use, are considered to be minimal and are therefore not computed.
- The form and structure of permanent, farm residences is of a two-storey variety with an average floor area size of 100 square metres (1,100 square feet), excluding basement areas, with associated space heating requirements of approximately 85,000 MJ per unit per annum, with forced air, oil heating (assumed furnace efficiency of 60 percent).

2.1 *Introduction of Hamlets (Test R1)*

Objective

- The objective of test R1 is to examine the impact on baseline model levels of energy consumption of the introduction of two strategically-located hamlets, the functions of which are to serve the basic shopping needs of the seasonal residential population thereby reducing energy consumption associated with travel to service commercial centres.

Land Use

- Cottages are assumed to be the dominant land use.
- The types of functions to be offered within the hamlets include family service shopping and recreation, as well as education facilities for school-age permanent residents.
- In addition to serving as the focal point for shopping, recreation and educational activities, the hamlets also serve a residential function - 50 permanent dwellings are incorporated into each hamlet.

Residential Development and Population

- The total number of cottage dwellings remains the same at 375 while the total number of permanent dwellings increases to approximately 125, reflecting the addition of 100 hamlet residences (50 per hamlet).

- On the basis of the average household sizes assumed in the baseline model, the seasonal residential population for test R1 remains at 1,575 and the permanent population increases to approximately 375 for a total township population of 1,950 during the May-October period, and 375 during the November- April period.

Travel Patterns

- Permanent residents make daily return trips to and from a destination located outside of the township for employment purposes.

2.2 *Hamlets and Clustered Development (Test R2)*

Objective

- Test R2 considers the energy consumption implications of the incorporation of clustered cottage development into areas of the township.

- Test R2 builds upon both the recreation baseline model and test R1.

Land Use

- Each cluster contains approximately 65 seasonal residences (130 total) organized in a clustered manner, instead of a strip fashion, as are the majority of other seasonal residences.
- This consideration attempts to portray recreation-oriented "communities" recently established in the Lake Simcoe and Haliburton areas and to a lesser degree, the Muskoka area.
- Service shopping, recreation and education facilities are contained within the two hamlets as introduced in test R1.

Residential Development and Population

- With the introduction of clustered cottage developments, the total number of permanent residences remains at 125, as in test R1.
- The total seasonal residential population, therefore, increases to 2,120 while the total permanent residential population remains at 375, for a total township population of 2,375 during the November - April period and 2,495 during the May - October period.

Travel Patterns

- Travel assumptions are as contained in the recreation baseline model, as amended by test R1.

2.3 *Conversion to Permanent Residences (Test R3)*

Objective

- Test R3 considers the effect on baseline levels of energy consumption of the conversion of approximately 25 percent of the seasonal residential housing units to permanent dwellings, reflecting the attractiveness of the township as a place of retirement for previous seasonal residents.
- Test R3 is intended to build upon the recreation baseline model, as amended by both tests R1 and R2.

Land Use

- The location of the 25 percent of cottages converted to permanent residences (approximately 130 units) is assumed to be on a scattered basis within the township.

Residential Development and Population

- The total number of residences in the township remains at approximately 630. However, the conversion of 130 seasonal residences to permanent residences increases the number of permanent residences to 255 and decreases the number of seasonal residences to 375.

- The total permanent residential population increases to 765 while the total seasonal residential population decreases to 1,575 for a total township population during the period May to October of 2,340, and 765 during the November to April period.

Travel Patterns

- The assumption contained in test R2 regarding permanent population and commuting to employment has been amended to recognize an increase in the permanent population.

Residential Space Heating Requirements

- The conversion of seasonal residences to permanent dwellings requires the additional consideration of space heating needs for the newly converted units. Allowing for no major structural changes, only the addition of a heating system and insulation, the space heating needs of the newly converted residences are assumed to be approximately 70,000 MJ per unit per annum, with forced air, oil heating (assumed furnace efficiency of 60 percent).

SUMMARY OF ASSUMPTIONS

RECREATION BASELINE MODEL AND TESTS

Characteristics	Recreation Baseline Model	Test R1 Introduction of Hamlets	Test R2 Hamlets & Clustered Development	Test R3 Conversion to Permanent Residences
	ASSUMPTIONS			
1. Land Use Pattern Considerations				
.total township area	29,100 hectares	29,100 hectares	29,100 hectares	29,100 hectares
.permanent (farm) residences	25 residences (scattered)	125 residences (50 permanent dwellings included in each hamlet)	125 residences	125 plus 130 converted cottages for 255 permanent dwellings
.# of seasonal residences	375, predominately strip development	375	505 cottages in clustered form	375 (130 in clustered form)
.total # of residences	400 total residences	500 total residences	630 total residences	630 total residences
2. Demographic Characteristics				
.permanent(farm) population (3.0 pers/res.)	75	375	375	765
.seasonal population (May-Oct.) (4.2 pers/res.)	1575	1575	2120	1575
.total township population (May-Oct.)	1650	1965	2495	2340
(Nov.-April)	75	375	375	765

Summary of Assumptions - Recreation ..... contined ..../2

Characteristics	ASSUMPTIONS Recreation Baseline Model	Test R1 Introduction of Hamlets	Test R2 Hamlets & Clustered Development	Test R3 Conversion to Permanent Residences
3. Travel Patterns				
	all trips to nearby urban centre located outside	all trips to hamlet except permanent employment	all trips to hamlet except permanent employment	all trips to hamlet except permanent employment
Journey from permanent residences to:				
.place of work	1 return trip per working day to destination outside township	same as Baseline Model	same as Baseline Model	same as Baseline Model
.family service shopping	1 return trip per day (outside township)	1 return trip per day (hamlet)	1 return trip per day (hamlet)	1 return trip per day (hamlet)
.education	1 return trip per school day (outside township)	1 return trip per day (hamlet)	1 return trip per day (hamlet)	1 return trip per day (hamlet)
.recreation	2 return trips per week (outside township)	2 return trips per week (hamlet)	2 return trips per week (hamlet)	2 return trips per week (hamlet)
Journey from seasonal residences to:				
.family service shopping	1 return trip per day (outside township)	1 return trip per day (hamlet)	1 return trip per day (hamlet)	1 return trip per day (hamlet)
.recreation	1 return trip per week (outside township)	1 return trip per week (hamlet)	1 return trip per week (hamlet)	1 return trip per week (hamlet)

Summary of Assumptions - Recreation ..... contined ..../3

Characteristics	Recreation Baseline Model	Test R1 Introduction of Hamlets	Test R2 Hamlets & Clustered Development	Test R3 Conversion to Permanent Residences
		ASSUMPTIONS		
4. Vehicles				
	all vehicles will be North American style	same as Baseline Model	same as Baseline Model	same as Baseline Model
	school bus to each permanent residence (1.8 km/litre) (1 bus required)	(1 bus required)	(1 bus required)	(1 bus required)
5. Maintenance				
	3 trips per winter week for snow removal and sanding on principal roads to permanent settlement areas (1.8 km/litre) (20 week season)	same as Baseline Model	same as Baseline Model	same as Baseline Model
6. Residential Space Heating Requirements				
.Average Permanent (Farm)	two storey, 100 square metres	two storey, 100 square metres	two storey, 100 square metres	two storey, 100 square metres
.Average Space Heating Requirement (per annum)	85,000 MJ	85,000 MJ	85,000 MJ	85,000 MJ
.Average Seasonal Dwelling Size	one floor, 85 square metres	one floor, 85 square metres	one floor, 85 square metres	one floor, 85 square metres
.Space Heating Requirement	N/A	N/A	N/A	N/A

one

3.0 *The Renewable Resource Baseline Model*

Land Use

- Forest harvesting is the dominant primary economic activity.
- The main secondary economic activity is also forestry-related, in the form of a pulp mill.
- The major employment opportunities within the township are, therefore, either directly or indirectly related to the forest industry.
- The pulp mill is located in proximity to a serviced townsite which serves to concentrate all major non-industrial activities including commercial, institutional, recreational and residential uses.
- The only form of land use, other than primary industry, located outside of the townsite is scattered rural residential development.

Area and Unit Size

- The total township area is approximately 22,500 hectares or 225 square kilometres (56,000 acres).

Residential Development and Population

- The total number of permanent residences contained within the townsite area is assumed to be 650.
- The total number of permanent residences located within the rural portion of the township is assumed to be 100.
- The average household size in the townsite area is 3.4, and in the rural area 3.2, for a total townsite population of 2,210, total rural population of 320, and a total township population of 2,530.

Travel Patterns

- The major sources of employment, for townsite and rural residents alike, are the pulp mill (75 percent of work force), forest harvesting operations (variable locations) (20 percent of work force), and in a distant urban centre (5 percent of work force).
- For persons working in the logging camp, work-oriented travel is by individual vehicle to a centralized depot located in the townsite from which buses transport workers to the location of logging activity.
- Shopping for groceries and sundry convenience items occurs within the townsite, with rural residents making 2 return trips per week for such items.
- For specialty shopping, major forms of entertainment and the services of a medical practitioner, rural residents, and residents of the townsite alike, make 1 return trip every 2 weeks to a distant urban centre (located outside of the township).

Residential Space Heating Requirements

- The form and structure of both rural and townsite residences is a one-storey, detached frame dwelling with an average floor area of 93 square metres (1,000 square feet), excluding basement areas, with associated space heating requirements of approximately 105,000 MJ per unit per annum, with forced air, oil heating (furnace efficiency of 60 percent).

3.1 *Addition of Hamlet (Test F1)*

Objective

- Test F1 builds upon the renewable resource baseline model with the introduction of a hamlet, strategically located

at the junction of major township roads. The purpose of the hamlet is to reduce the amount of energy consumed by rural residents in travelling to the townsite for basic services (grocery and sundry shopping, formal recreation facilities, education).

Land Use

- The primary land use considerations contained in the baseline model are preserved.
- The hamlet located in the rural area contains retail shopping facilities (general clothing store, grocery and convenience shopping, liquor/beer store), education facilities, limited recreation facilities in the form of a community centre (meeting rooms, auditorium/gymnasium, outdoor play fields), and the "part-time" offices of a general medical practitioner.
- The location of shopping opportunities related to grocery and sundry items is in the hamlet, for all rural and hamlet residents, and in the townsite, for all townsite residents.
- Entertainment facilities (theatres, arenas) and shopping opportunities have been introduced into the townsite area thereby reducing the amount of travel to a distant outside urban municipality.

Residential Development and Population

- The hamlet also contains 50 permanent dwellings, raising the number of residences located outside of the townsite to 150, while the number of residences located in the townsite remains at 650, for a total of 800 residences within the township.
- The total population located in the rural area is 480, and within the townsite 2,210, for a total township population of 2,690.

Travel Patterns

- As a result of the increased level and amount of shopping opportunities and entertainment services available locally, the frequency of trips to an outside urban municipality is reduced to 1 per household every fourth week rather than every second week.

3.2 *Improved Road Network: (Test F2)*

Objective

- The objective of test F2 is to evaluate the effect on levels of energy consumption, experienced in the baseline model, of an improved road network, exclusive of consideration of a hamlet.

Land Use

- Particular attention is paid in this test to road patterns in the rural area especially with respect to improving access to the townsite, improving access on and off the highway to the townsite, as well as access to logging activity.
- Also considered within the context of this model is a more suitably located bus depot for purposes of transporting workers to the site of logging activity.

3.3 *Hamlet and Improved Road Network: (Test F3)*

Objective

- The objective of test F3 is to examine the combined effects of both test F1 and test F2 on levels of energy consumption experienced in the baseline model.

Land Use

- Test F3 incorporates the hamlet, as introduced in test F1, which provides an alternative to scattered rural residential development and improved shopping opportunities for rural residents, as well as an improved road network, as introduced in test F2, which provides more direct access to: the townsite, on and off the highway, and to the location of logging activity.

Residential Development and Population

- The total number of residences and residents are as per test F1 - 800 residences (650 townsite, 100 rural, 50 hamlet) and 2,690 residents (2,210 townsite, 320 rural, 160 hamlet).

Travel Patterns

- Travel patterns are as per tests F1 and F2 regarding employment and shopping destinations, with travel to the outside urban area occurring once every fourth week as per test F1.

Section 3 contains all of the various relevant observations and conclusions with respect to the total energy consumed in each of the baseline cases, as well as the effects on the baseline energy consumption of each of the tests.

SUMMARY OF ASSUMPTIONS

RENEWABLE RESOURCE BASELINE MODEL AND TESTS

Characteristics	ASSUMPTIONS			
	Renewable Resource Baseline Model	Test F1 Addition of Hamlet	Test F2 Improved Road Network	Test F3 Hamlet and Improved Road Network
1. Land Use Pattern Considerations				
.total township area	22,500 hectares	22,500 hectares	22,500 hectares	22,500 hectares
.# of residences -townsite	650 residences	650 residences	650 residences	650 residences
.# of residences -rural areas	100 residences	150 residences (includes 50 dwellings in hamlet)	100 residences	150 residences (includes 50 dwellings in hamlet)
.total # of residences	750 residences	800 residences	750 residences	800 residences
2. Demographic Characteristics				
.townsite population (3.4 pers/ res.)	2,210	2,210	2,210	2,210
.rural areas population (3.2 pers/ res.)	320	480	320	480
.total township population	2,530	2,690	2,530	2,690
3. Travel Patterns				
Journey to work:				
.pulpmill (75% of work force)	1 return trip per working day	1 return trip per working day	1 return trip per working day (improved road network)	1 return trip per working day (improved road network)

Summary of Assumptions - Renewable Resource ..... continued ..../2

Characteristics	Renewable Resource Baseline Model	ASSUMPTIONS Test F1 Addition of Hamlet	Test F2 Improved Road Network	Test F3 Hamlet and Improved Road Network
3. Travel Patterns (cont'd) ...				
.logging camps (20% of work force)	1 return trip per day to bus depot (school bus used for journey to logging camp)	same as Baseline Model	same as Baseline Model	same as Baseline Model
.outside urban centre (5% of work force)	1 return trip per working day to outside urban centre	same as Baseline Model	same as Baseline Model (better access to major road)	same as Baseline Model (better access to major road)
Shopping & Service Needs:				
.groceries and sundries	2 return trips per week to townsite for rural households - townsite shopping not computed	rural household weekly shopping now in hamlet - townsite shopping not computed	2 return trips per week to townsite for all rural households - townsite shopping not computed	rural household weekly shopping now in hamlet - townsite shopping not computed
.doctor, entertainment, specialty shopping	1 return trip every two weeks to outside urban centre for all households	1 return trip every four weeks to outside urban centre for all households due to improved local functions	1 return trip every two weeks to outside urban centre for all households	1 return trip every four weeks to outside urban centre for all households due to improved local functions
4. Vehicles	all vehicles will be North American style (7 km/litre). School bus used for transportation to education facility in townsite (1.8 km/litre) (2 buses required)	same as Baseline Model except rural and hamlet students attend education facility in hamlet (3 buses required)	same as Baseline Model (2 buses required)	same as Baseline Model except rural and hamlet students attend education facility in hamlet (3 buses required)

Summary of Assumptions - Renewable Resource ..... continued ..../3

Characteristics	Renewable Resource Baseline Model	ASSUMPTIONS Test F1 Addition of Hamlet	Test F2 Improved Road Network	Test F3 Hamlet and Improved Road Network
5. Maintenance				
	3 trips per winter week for snow removal and sanding on all roads (1.8 km/litre) (20 week season)	same as Baseline Model	same as Baseline Model	same as Baseline Model
6. Residential Space Heating Requirements				
.Average Town-site/Hamlet/ Rural Dwelling Size	one storey frame 93 square metres	one storey frame 93 square metres	one storey frame 93 square metres	one storey frame 93 square metres
.Average Size Space Heating Requirement (per annum)	105,000 MJ	105,000 MJ	105,000 MJ	105,000 MJ

APPENDIX III

Energy Consumption - Baseline Models and Tests

TRANSPORTATION

a) Automobile Travel

	Number of Households				Population			
	Base	A1	A2	A3	A1	A2	A3	
Farm	500	500	500	500	2,000	2,000	2,000	2,000
Non-Farm	50	300	325	350	150	900	975	1,050
TOTAL	550	800	825	850	2,150	2,900	2,975	3,050

Distance Travelled (x 10^3) -Farm Commercial Centre (km)					Distance Travelled (x 10^3) -Shopping Service Needs (km)				Distance Travelled (x10^3) - Recreation (km)				Distance Travelled (x 10^3) - To Work (km)			
	Base	A1	A2	A3	Base	A1	A2	A3	Base	A1	A2	A3	Base	A1	A2	A3
Farm	7,293	7,293	4,740	4,740	2,188	2,188	1,422	1,422	1,459	1,459	948	948	-	-	-	-
Non-Farm	-	-	-	-	227	1,305	915	1,133	151	870	823	755	377	2,174	2,193	2,084
TOTAL	7,293	7,293	4,740	4,740	2,415	3,493	2,337	2,555	1,610	2,329	1,771	1,703	377	2,174	2,193	2,084

Fuel Consumption (x 10^3) (litres) (assume 7 litres/km)

Farm	1,042	1,042	677	677	313	313	203	203	208	208	135	135	-	-	-	-
Non-Farm	-	-	-	-	32	186	131	162	22	124	118	108	54	311	313	298
TOTAL	1,042	1,042	677	677	345	499	334	365	230	333	253	243	54	311	313	298

Annual Per Capita Fuel Consumption (litres/person/year)

Farm	521	521	339	339	157	157	102	102	104	104	68	68	-	-	-	-
Non-Farm	-	-	-	-	213	207	134	154	147	138	121	103	360	346	321	283
TOTAL	485	359	228	222	160	172	112	120	107	115	85	80	25	107	105	98

b) Road Maintenance and School Bus Travel

	Maintenance & Snow Removal (kms)(x 10^3)				School Buses x 10^3 (km)			
	Base	A1	A2	A3	Base	A1	A2	A3
Total Distance Travelled	70	70	70	70	226	318	277	277
Fuel Consumption (litres) (assume 1.8 km/litre)	39	39	39	39	126	177	154	154
Annual Per Capita Fuel Consumption (litre/ person/year)	18	13	13	13	59	61	51	51

c) Total Transportation Energy Consumption

Total Travel Mileage (x 10^3) (km)				Total Fuel Consumption (x 10^3) (litres)				Total Annual Per Capita Fuel Consumption (litres/person/yr.)			
Base	A1	A2	A3	Base	A1	A2	A3	Base	A1	A2	A3
11,99!	15,677	11,388	11,429	1,836	2,401	1,770	1,776	854	827	594	584
Total Annual Transportation Consumption (GJ x 10^3)				63.3	82.8	61.0	61.0	29.4	28.4	20.4	20.1

Total Annual Per Capita Transportation Energy Consumption (GJ)

SPACE HEATING

a) Residential Space Heating Requirements

	Number of Residences			
	Base	A1	A2	A3
Farm	500	500	500	500
Non-Farm	50	300	325	350
TOTAL	550	800	825	850

Total Annual Space Heating Energy Consumption (GJ x 10^3)

Total Heating Fuel Consumption (litres)(x 10^3)				Total Annual Per Capita Heating Fuel Consumption (litres/person/yr.)			
Base	A1	A2	A3	Base	A1	A2	A3
2,750	2,750	2,750	2,750	1,375	1,375	1,375	1,375
222	1,332	1,443	1,555	1,480	1,480	1,480	1,480
2,972	4,082	4,193	4,305	1,382	1,407	1,409	1,411
117.6	161.6	166.0	170.4	54.4	55.4	55.4	55.6

Total Annual Per Capita Space Heating Energy Consumption (GJ)

ENERGY CONSUMPTION - RECREATION BASELINE MODEL AND ASSOCIATED TESTS

TRANSPORTATION

a) Automobile Travel

	Number of Households				Population				Distance Travelled (kms)($x10^3$) -Shopping, Service Needs				Distance Travelled (kms)($x10^3$) -Recreation & Spec. Activities				Distance Travelled (kms)($x10^3$) - To Work			
	Base	R1	R2	R3	Base	R1	R2	R3	Base	R1	R2	R3	Base	R1	R2	R3	Base	R1	R2	R3
Permanent	25	125	125	255	75	375	375	765	85	109	109	378	34	44	44	152	85	1,532	1,532	1,532
Seasonal (Cottage)	375	375	505	375	1,575	1,575	2,120	1,575	3,942	753	858	731	2,277	435	495	423	-	-	-	-
TOTAL	400	500	630	630	1,650	1,950	2,495	2,340	4,027	862	967	1,109	2,311	479	539	575	85	1,532	1,532	1,532

Fuel Consumption ($x10^3$) (litres)(assumes 7 litres/km)

Permanent	12	16	16	54	5	6	6	22	12	219	219	219
Seasonal (Cottage)	563	108	123	104	325	62	71	60	-	-	-	-
TOTAL	575	124	139	158	330	68	77	82	12	219	219	219

Annual Per Capita Fuel Consumption (litres/person/year)

Permanent	160	43	43	71	67	16	16	29	160	584	584	286
Seasonal (Cottage)	357	69	58	66	206	39	33	38	-	-	-	-
TOTAL	348	64	56	68	200	35	31	35	7	112	88	94

b) Road Maintenance and School Bus Travel

	Maintenance and Snow Removal Equipment (kms)				School Buses ($x10^3$)(kms)			
	Base	R1	R2	R3	Base	R1	R2	R3
Total Distance Travelled	3,072	3,072	3,342	3,342	21	15	15	32
Fuel Consumption (litres) (Assume 1.8 km/litre)	1,707	1,707	1,857	1,857	12	8	8	18
Annual Per Capita Fuel Consumption (litres/person/yr.)	1.0	0.9	0.7	0.8	7.2	4.1	3.2	7.7

c) Total Transportation Energy Consumption

Total Travel Mileage ($x10^3$) (kms)				Total Fuel Consumption ($x10^3$)(litres)				Total Annual Per Capita Fuel Consumption (litres/person/yr.)				
Base	R1	R2	R3	Base	R1	R2	R3	Base	R1	R2	R3	
6,447	2,891	3,056	3,251	931	421	445	480	563	216	179	206	
Total Annual Transportation Energy Consumption (GJ x 10^3)				32.1	14.5	15.3	16.6	19.4	7.5	6.2	7.1	Total Annual Per Capita Transportation Energy Consumption (GJ)

SPACE HEATING

a) Residential Space Heating Requirements

	Number of Residences				Total Fuel Consumption ($x10^3$)(litres)				Total Annual Per Capita Fuel Consumption (litres/person/yr.)				
	Base	R1	R2	R3	Base	R1	R2	R3	Base	R1	R2	R3	
Permanent	25	125	125	255	90	450	450	834	1,200	1,200	1,200	1,090	
Seasonal (Cottage)	375	375	505	375	-	-	-	-	-	-	-	-	
TOTAL	400	500	630	630	90	450	450	834	55	231	180	356	
Total Annual Space Heating Consumption (GJ x 10^3)					3.5	17.8	17.8	33.0	2.2	9.1	7.1	14.1	Total Annual Per Capita Space Heating Energy Consumption (GJ)

TRANSPORTATION

a) Automobile Travel

	Number of Households				Population				Distance Travelled ($x10^3$)(kms) -Shopping, Service Needs				Distance Travelled ($x10^3$)(kms) -Recreation & Spec. Activities				Distance Travelled ($x10^3$)(kms) -To Work			
	Base	F1	F2	F3	Base	F1	F2	F3	Base	F1	F2	F3	Base	F1	F2	F3	Base	F1	F2	F3
Townsite	650	650	650	650	2,210	2,210	2,210	2,210	323	323	323	323	2,191	1,095	2,051	1,026	2,161	2,161	1,891	1,891
Rural Area (includes hamlet)	100	150	100	150	320	480	320	480	103	191	98	186	321	240	320	239	507	826	498	818
TOTAL	750	800	750	800	2,530	2,690	2,530	2,690	426	514	477	510	2,512	1,335	2,372	1,266	2,668	2,987	2,389	2,710

Fuel Consumption ($x10^3$)(litres)(assume 7 litres/km)

Townsite	46	46	46	46	313	157	293	147	309	309	270	270
Rural Area (includes hamlet)	15	27	14	27	46	34	46	34	72	118	71	117
TOTAL	61	73	60	73	359	191	339	181	381	427	341	387

Annual Per Capita Fuel Consumption (litres/person/year)

Townsite	21	21	21	21	142	71	133	67	140	140	122	122
Rural Area (includes hamlet)	47	56	44	56	144	71	144	71	225	245	221	244
TOTAL	24	27	24	27	142	71	134	67	151	159	135	144

b) Road Maintenance, Logging Buses, and School Bus Travel

	Maintenance & Snow Removal ($x10^3$)(kms)				Buses to Logging Activity ($x10^3$)(kms)				School Buses ($x10^3$)(kms)			
	Base	F1	F2	F3	Base	F1	F2	F3	Base	F1	F2	F3
Total Distance Travelled	10	10	12	12	15	30	12	24	21	27	20	27
Fuel Consumption (assume 1.8km/litre)	5	5	7	7	8	16	7	14	12	15	11	15
Annual Per Capita Fuel Consumption (litres/person/year)	2	2	3	3	3	6	3	5	5	6	4	6

c) Total Transportation Energy Consumption

Total Travel Mileage ($x10^3$)(kms)				Total Fuel Consumption ($x10^3$)(litres)				Total Annual Per Capita Transportation Fuel Consumption (litres/person/year)				
Base	F1	F2	F3	Base	F1	F2	F3	Base	F1	F2	F3	
5,652	4,876	5,207	4,549	826	727	765	677	326	270	302	252	
Total Annual Transportation Energy Consumption (GJ x 10^3)				28.5	25.1	26.4	23.3	11.2	9.3	10.4	8.7	Total Annual Per Capita Transportation Energy (GJ)

SPACE HEATING

a) Residential Space Heating Requirements

	Number of Residences				Total Heating Fuel Consumption (litres)($x10^3$)				Total Annual Per Capita Heating Fuel Consumption (litres/person/year)				
	Base	F1	F2	F3	Base	F1	F2	F3	Base	F1	F2	F3	
Townsite	650	650	650	650	2,887	2,887	2,887	2,887	1,306	1,306	1,306	1,306	
Rural Area (includes hamlet)	100	150	100	150	444	666	444	666	1,390	1,390	1,390	1,390	
TOTAL	750	800	750	800	3,331	3,553	3,331	3,553	1,320	1,320	1,320	1,320	
				Total Annual Space Heating Energy Consumption (GJ x 10^3)	131.9	140.7	131.9	140.7	52	52	52	52	Total Annual Per Capital Space Heating Energy Consumption (GJ)

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